free from the ravages of famine, wild animals, venomous snakes and insects. The snowy mountains of Tési, Chomo-kankar, Phulahari, Kula-kangri in Lhobra, Habe in Upper *Ñ*ang, Chhyi-kang, Tsarita and Ñan-chhen-thangla in *Do-k*lands, Yarlha Shambu, Toirikarpo, Kha-wa-Lodi*l*, Shabra Karpo, Machhen Pomra, and others stand exalted with uplifted hoary heads, like so many glittering *chhortens* of rock crystal. There are also the mountains called Hoti-gongya*l*, Mari Rab Chyam, Jomo nagri, Kong-tsun-demo, &c., abounding in numerous fragrant herbs of wonderful medicinal properties, and clothed in charming pasture. Besides these, numberless black mountains fill the country. The lakes are Mapham *G*yu-*m*tsho, *G*nam-*m*tsho phyug mo, Tsha-*m*tsho, Yar-*h*brog *g*yu-*m*tsho, Phag-*m*tsho, *M*tsho *s*kyareng *s*ngoreng, Khri-*g*shor, Gya*l*-mo. Numerous other lakes of sweet, pure and sparkling water are scattered all over the country. The great rivers such as the Tsang-po, Senge khabab (Indus), Mab-chya khabab, Tsha-shika, *L*ja-chhu *D*ngu*l*-chhu, *H*bri-chhu, *G*ser-gyi phye-ma (Golden sand), Ñag-chhu, *R*gya*l*-mo *D*ngu*l*-chhu, *R*[illegible]-chhu (Hoangho), *S*me-chhu *R*be-chhu, *B*[illegible]ng-chhu, *H*julag-chhu, *B*tsong-chhu, fed by numerous tributaries, flow towards its boundaries. Extensive forests, pasture lands, grassy valleys, meadows, fields abound there. Barren and bleak plateaux, which look like deserts and [illegible] plains, occupy the largest area of the country. The great countries of *R*gya-nag (China), *R*gya-gar (India), Persig (Persia) have great oceans on their borders, but the country of Tibet stands surrounded by the mighty barriers of snowy mountains, skirting which are the kingdoms of *R*gya-nag, *R*gya-gar, *H*jang, Mon (Cis-Himálcyá), Ba*l*-yo (Nepal), Kha-chhe (Kashmir), Stag-*g*ssig*s* (Tajik or Persia) and Hor (Tartary), inhabited by various peoples. As the great rivers which fertilise these border countries have their sources in the country of Po (Bhot or Tibet), the latter stands to other countries in the relation of Dsambuling (Jambudvipa) as their centre.

This great country is divided into three parts—

I.—*S*to*d* *M*ngah-ri *s*kor-*g*sum ...	High (or Little) Tibet.
II.—*D*vu*s* *G*tsang, divided into four provinces, ...	Tibet Proper.
III.—*M*do, kham*s* and *S*gang, ...	Great Tibet.

I.—LITTLE TIBET (BOD-CHHUNG.)

*S*to*d* *M*ngah-ri *s*kor-*g*sum is divided into the three following circles:—*S*tag-mo *L*advag*s*, Mang-yu*l* Shang Shung, Guge Buhrang (Purang); and into the following districts:—

Purang, Mang-yul, Sang*s*-*d*kar, *H*Chhi-va, *B*la-sha, *S*bal-te, Shang Shung, Upper and Lower Khrig-se.

tants.) The people of these places partly resemble the Kashmiris in one manner of dressing and living. They wear a kind of hat with a broad brim called *cho-shva*, and similar to the hat of a Chinese convict. The laymen wear black *cho-shva*, the clergy red ones. Formerly the people of Ngahri were devoted to the Chhyaggya-pa and Dsog-chhen-pa sects of the red cap school, but now-a-days they are imbibing faith in the reformed Gelugpa doctrine. To the north-west of Ladvag is the small district of *S*Pite, the people of which belong to the Tibetan race, and are subject to the Ladvag chief. To the west of *S*Pite there is a place called Kamlasha, where there is a snowy mountain called Boidur-thaka by the Lalos (Muhammadans). To the east of Ngari Ladvag there is a tribe known by the name *H*dar-wa, to the east of whose country there lies the little province of Gugé.

The most notable object in Gugé is the monastery of Thoding (*M*thó *l*ding gSergyi Lhakhang), founded by the celebrated Lochava Rinchhen Ssangpo. Thence proceeding eastward for a day you come to the district of Purang, where reigned a line of kings sprung from the dynasty of King Srong tsan Gampo. Lha Lama Chyangchhub *H*od was the most illustrious member of this line of kings. The chief town of Purang is Ya-tse dsong, which contains several Gelugpa institutions, such as Purang Shing-phelling and others. In Purang there are many religious institutions belonging to the Sakyapa, *R*ñiingmapa, Karmapa, *H*brug-pa, Bonpo and other schools.

Proceeding half a day's distance to the south of Purang you arrive at the very old and famous sanctuary of Chovo Jamali, also called Khur-Chhog. In ancient time there lived in a remote part of Purang a recluse, who entertained seven Aryan Buddhists in his humble cell. These Acharyas, when they were returning to *R*gya-gar, entrusted him with seven loads of articles belonging to them for safe custody. Years elapsed, yet they did not return to Purang. The recluse, thinking that they would not return to Tibet, opened the loads and therein found many bundles wrapped in rags with the name "Jamali" marked on them; and on opening them he found that they contained silver ingots. Carrying these treasures, the recluse went to a place called Jûmlang, where he engaged several silversmiths to construct an image of Lord Buddha with the entire quantity of silver. As soon as the image was finished down to its knees, it began to move, though the legs were not finished. Thereafter the recluse, with a view to take the image to Tibet, engaged porters to carry it, and succeeded in placing it on the site of this temple. As soon as the image reached Purang it became immoveable and remained fixed where it was first placed. A temple was then erected to shelter and honour it. On account of the name Jamali being marked on the bundles ver ingots with which it was constructed, it is called Jamali, "the immoveable." Again, when the Turushka armies under King Boramjee (or Noramjee) captured Chittore, the king and his brother, carrying with them the images of Chanrassig Wangchhyug and his wife, retired to Kang Tesi. When arrived at Purang, he found that Chanrassig's image could not be moved or carried any further; but from underneath the spot where the image stood there sprung out miraculously a seat of *amalaka* stone with an iron lotus on it, while a voice was heard directing the king to leave the image there. The royal brothers at the end of their pilgrimage in Tibet returned to Nepal, carrying with them the image of Dolma. There the elder brother obtained the principality of Jûmlang, and the younger brother, more fortunate, the kingdom of Nepal. The latter, after reigning several years, abdicated the throne and went to Southern India, where he obtained the chieftainship of a large principality.*

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* [With regard to this incident, Mr. H. B. Beveridge sends us the following note. "The Tibetan Chronicle speaks of the Turushka, that is, Muhammadans under King Boramji. But I suspect a mistranslation here, and think that Boramji must be the name of the Chitor Hindu king, and not of the Muhammadan conqueror who, I think, ought to be Alauddín Khiljí who sacked Chitor in 1303. I applied to my friend the Kaviráj Shyámal Dás, and he has given me the following useful note which, I beg to suggest, might be put as a note to the passage in the Tibetan chronicle.

The Kaviraj writes as follows:

" " Boramji, or Noramji may be a corruption of Barbarm (बरबंम) who was the son of Ayút (अयूत) and grandson of Kúmbha Karan (कुंभकरण) son of Rawal Samar Singh of Chitor. It is known from the Prithvá Ráj Rása that Kumbha Karan sought shelter towards Ujjein after leaving Chitor, when Alauddin Khilji sacked it in the time of Samar Singh; and his descendants went to Nepal, a fact which is admitted by the Nepalese. Nepal may be meant by Tibet in the chronicle you speak of." "

I think that there is something in the Kaviráj's suggestion, though I cannot find Barbarm in Tod. On the other hand I find one Ajeysi there, Vol. I, p. 269, and Tod says that he had two sons, one of whom by name Sujunsi was the ancestor of Sivaji, the founder of the Asattara dynasty. May not this be the more fortunate prince of the Tibetan chronicle who became a ruler in Southern India? In a footnote to the page of Tod just quoted, he says, that two noble lines were reared from expelled princes of Chitor; those of Sivaji, and the Gorkhas of Nepal. At p. 257 Tod refers to a son of Samar Singh who fled to the mountains of Pal, and there spread the Gehlote line. According to Tod and the Rajput bards, Samar Singh lived nearly 150 years before Alauddín, but I suppose this is one of the anachronisms, which the Kaviráj has set himself to rectify. Perhaps Dr. Wright's History of Nepal might throw light on the subject of Chitor princes in Nepal, or Tibet."—Ed.]

Antiquities at Nagarí.—*By* Kavi Ráj Shyámal Dás, M.R.A.S., F.R.H.S.

Translated by Babu Rám Prasád. *(With two Plates.)*

Nagarí is a small village in Mewár and is situated on the east or right bank of the Berach, about six miles north-east of Chitoṛ. At one time it was part of the jágír of the Ṭhákur of Bassí, but it is now included in the estate of the Ráo of Bedlá, a Chauhán Rájpút and a first class vassal of the Maháráná of Udaypur who belongs to the Guhilot or Gehlot clan. The name of this clan is derived from Guhil, the son of the Bappá Ráwal who in Samvat 784, A. D. 728, according to Col. Tod, or S. 791, A. D. 735, as I believe, took Chitoṛ from Mán'morí, the last of the Morí or Pramar dynasty.*

Though we do not know the dates of the foundation, or the destruction of Nagarí, yet the latter event must have occurred before the time of Bappá who lived more than eleven centuries ago; and it would seem from two inscriptions at Nagarí being in the Southern Aśoka character that the city was flourishing before the Christian era. The inhabitants point out the remains of an ancient fort at Nagarí, and say that its moat was formed by a ravine lying to the eastward. An examination of the spot shows that some building must have stood there, for large bricks are occasionally dug up in the neighbourhood. The north-east and south quarters of Nagarí also contain many isolated specimens of ancient architecture. The old rampart of the town is said by the villagers to be represented by a crescent-shaped embankment which skirts Nagarí, commencing on the south at the river and encompassing the south-east, east and north-east quarters, and ending at the north on the river bank again. The entrance to the old city is traceable on the road leading to Bassí. In some places we find old mortar floorings, and sometimes masonry gháṭs are exposed to view by the erosion of the river banks.

Two earthen vessels measuring 12 feet in height and 3 in diameter, with sides an inch thick, are to be seen in the shaft of a well sunk by a barber. Such vessels called *nánd* (नांद), 3 to 4 feet high and $1\frac{1}{2}$ in diameter, are manufactured at the present day by potters on their wheels, but those two old vessels seem to have been constructed by joining several layers, each 4 inches high, and then baking them in a kiln. The rims of similar vessels may be seen peeping out from the ground in two other places.

Háthioṃ ká báṛá.

About half a mile east of the village there is an open rectangu enclosure which goes by the above name, *i. e.*, the elephant-enclo

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* Tradition says that Chitrang Morí removed to Chitoṛ, on Nagarí havi doomed to destruction by the course of an ascetic.

XLIII. Ditto. Æ. 8—·55 grains. Shíráz, **90 H. Mr. Furdoonjee.

[باعي]	The same as No. XLI.
دار [العلم شيرا] ز	
ضرب	

Ditto. Æ. ·8—67 grains. Shíráz, **75 H. Mr. Furdoonjee.

شيراز	The same as No. XLI.
دار العلم	
ضرب	
•••۷۵	

XLIV. Fatḥ 'Alí Sháh (Qájár). Æ. ·95—138·5 grains. Mashhad, 1244 H. My cabinet.

عليه السلام	سكه فتحعلي شه
ضرب ۱۲۴۴	خسرو صاحبقران
مشهد امام	

XLV. Ditto. Æ. ·95—158 gr. Kirmán, 1219 H. Mr. Furdoonjee.

كرمان	شاه قاجار
دارالامان	فتحعلي
ضرب	السلطان ابن السلطان
۱۲۱۹	

XLVI. Ditto. Æ. ·85—44 gr. Shíráz, 1203 H. Mr. Furdoonjee.

شيراز	Similar inscription.
دارالعلم	
ضرب	
۱۲۰۳	

Ditto. Æ. ·50—37 grains. Yazd, no date. Mr. Furdoonjee.

يزد	Similar inscriptions.
العبا	
دالارد	

XLVII. (?) Muḥammad Khán. Æ. ·75—100 grains. Astarábád, 1173 H. Mr. Furdoonjee.

يا صاد	الله
الزمان	خلد
	ملكه استراباد
	ضرب ۱۱۷۳

XLVIII. (?) Sháh Ḥusain. Æ. ·8—57 grains. Ḥawaizah, no date. My cabinet.

In circle	الله	In circle	حويزه
	لي ولي		
	لا اله الا الله	Round	بنده ولايت حسين

Lower Purang in the east and not at a great distance from it, there is an extensive plain known by the name of Lava-manthang, and inhabited by a tribe of Tibetans. This was formerly under the government of Lhasa, but lately it has passed under the Nepalese rule. Then passing extensive *Dok* lands and proceeding in an easterly direction you come to the large district of Jonga Dsong, where there is a large fort with a prison attached to it, and several monasteries headed by Jongah Phel-gya Ling. Lower down to the east of Jonga Dsong lies the country of Tibet proper, consisting of the two great provinces of Tsang (*G*tsang) and U (*D*vu*s*). These were subdivided into four *Ru* or military quarters, namely, U-ru, Yeru, Yon-ru and Rulas. During the supremacy of the Hor Emperors, U and Tsang were divided into six districts each, called *Thi-kor*, and the lake country of Yamdo was constituted into a separate *Thi-kor*.

To the south of the Jonga district and the adjoining Dokpa lands lies the well-known district of Kirong, which is the most westerly part of Upper Tsang. At Kirong is the great monastery of Samtanling, which still preserves its reputation for sanctity. The monks of this ancient institution are famous for the purity of their morals and their exemplary discipline. Kirong contains the shrine of Chovo Wati Ssang-po, one of the four celebrated Chovo (Lord Buddha) of Tibet. To the south and in the neighbourhood of this Tibetan district lie Samkhu, Nayakota and other places of Nepal. Then proceeding eastward you arrive at Nalam, also called Nanam, adjoining which is Gungthang, the birthplace of Jetsun Milarapa and Rva Lochava.

II.—TIBET PROPER.

To the east and south of the Jongah district and the adjoining Dokpa lands, at the commencement of Upper Tsang, lies Mang-yul Kyidong (Kirong), adjoining the south boundary of which lie the Nepalese districts of Samkhu and Nayakota. Kirong contains the temple called Samtanling and the image of Buddha, celebrated by the name of Chovo Wati Ssang-po, from which a "lustre of glory" is said to issue at all times.

To the east of the Kirong district lies Nalam (Nanam), (to the south of which is the Nalam pass), in the vicinity of which are Gung thang, the birthplace of Rva Lochava and Toipa phug, the hermitage of the sage Milarapa, and Chhubar, the place where Milarapa died,—all these places lying on the Tibet-Nepal boundary. Close to them are the recluses' monasteries of Phelgya ling and Targya ling, in the neighbourhood of that grand and very lofty snowy mountain called Jomo Kangkar, and at the foot of Lab-chhyi Kang, on the top of which are the abodes of Tshe-ring tshe-nga, the five fairies who were devoted to the sage Milarapa. At the foot of Lab-chhyi Kang, on the Tibetan side, are five glacial lakes, each differing from the others in the colour of its water, consecrated to the Tshe-ring tshe-nga. To the north of those monasteries lies Kyema tsho, one of the four great glacial lakes of Tibet, close to which is situated Rivo tag-ssang ('the place considered holy'), the favourite residence of Lhacham Mandarava, the wife of Padma Sambhava, who resides there in a spiritual state. It contains the foot-marks of that deified female saint. Travelling northward from Nanam one arrives at the foot of a lofty mountain called Gung thang La, which contains the abodes of the twelve sylvan nymphs called Tanma Chuni, who were bound under solemn oath by Padma Sambhava to protect Buddhism against the heretical enemies or the Tirthikas (Bráhmanas), and to prevent ingress to Tibet of Indian heretics. Although it is alleged that since then the Indian Tirthikas never came to Tibet, yet it is found that the Indian Parivrajakas did, as they do now, visit Tibet. There are other passes and ways for communication between India and Tibet, besides Gung thang La pass, and so the nymphs cannot with certainty be said to have succeeded in their attempt to close the passes. Notwithstanding this, it is believed that formerly Indian heretics who succeeded in entering Tibet mostly died of, or suffered from, fatal and dangerous diseases. Many people say that the learned Parivrajakas (in the days of the author) who visited Tibet did not find the water and climate of Tibet to agree with them, and that they also suffered from serious diseases. After crossing Gung thang La, and going northwards, you arrive at the district of Tengri, in which there are the hermitage and cavern of Pha tampa Sangye (founder of the Shichye school), and the tomb of that famous saint. A Chinese guard with a Tibetan militia is posted at Tengri to watch the movements of the frontier people. Then to the east you find Tesi Jong and to the north Shel*kar* Dorje Jong with a prison attached to it. Close to it lies Shel*kar* Chhoide monastery. North-east of these, not at a great distance from Shel*kar* Jong, is situated the famous monastery of Pa*l* Sakya, which contains a grand congregation hall called *Dukhang karmo*, so spacious that within it a race can be run. Sakya contains numerous objects of Buddhist sanctity. The Sakya hierarchs descended from Khon Chhoigya*l* (although his temporal power is now extinct) continue to exist without interruption. They chiefly devote their attention to the Tantrik portion of Buddhism, for which they are greatly revered.

From Pa*l* Sakya if you go northward for a full day's march, you arrive at Khahu Tag Jong, the place where Lama Khahu propitiated the deity Gonpo sha*l*dub. It contains a cavern cut in a rock called *Pal Gon* *thim*, which contains a miraculously written white letter *A* called *Ayig* karpo, and a triangular hollow black rock slab called the Lodon (or the petrified heart of Pa*l*gom Lama,) from which faithful devotees take away chips. To the north of Khahu Jong there is a very lofty snowy range on the back of which is the district inhabited by a tribe of Hors called Toi Hor, said to be descended from Srinpo (cannibal hobgoblins). It is believed that if the snow of that mountain melt, great troubles and dangers will befall Tibet. The Sakya hierarchs, by the efficacy of their charms, are by degrees causing its snow to melt. This mountain is extremely high. Beyond these snowy mountains exist many Dok tribes. These Lalo (Muhammadan people) are subject to Kasgar.

After passing these, you arrive at tracts occupied by other Dokpa tribes, and the vast desert plain of *Nyanam*, where there is neither water, nor grass, nor vegetation. After crossing this desert plain you come to the district occupied by the Anchian tribe, a Muhammadan people, than whom none can do greater mischief to the cause of religion and peace. In ancient times, during the great dispute between Sakyapa and Digunpa monasteries, the latter invited the troops of Hasri Khán, the Lalo chief of Kasgar. In the war the Sakyapa attacked the enemy by marching along the side of the snowy mountains. Within the Yon Khang of Khahupa there are many bones and skulls, said to be the remains of those Lalo and Kasgar troops who fell in the battle. An account of this is to be found in the work Debther-nonpo.

Lower down, to the east of the *Nyanam* desert, the tract is called *Rongshar*, to the east of which lies *Chhudu* Tshogor and several other Yul-jong villages and towns. To the north of the famous monastery of *Pal* Sakya flows the river Tsangpo, on the bank of which stand Lha-rtse, Ngam-ring and Phun tsho*gs*-ling Jong, which all now belong to the Government of Tsang (*b*La-brang *r*Gya*l m*tshan *m*thonpo). These contain many symbols and images of great sanctity, as well as Thopu Chyam-chhen *chhorten* constructed by Thophu Lochava, a lofty *chhorten* erected by *Dub-chhen* (saint) Thanang, and the great temple built by *Situ* Namgya*l*-tagpa. Ngam-ring monastery, besides other religious institutions, is also a famous place of pilgrimage. The monastery of Phun-tsho-ling was built by Kun-khyen-jomo Nangpa *(Jonangpa)* after the model of the Buddhist temple of Sambhala. Phun-tsholing, Chholung-chyang-tse and other monasteries in Upper Tsang were formerly the seats of the spiritual descendants of Rwa-va, who devoted their attention exclusively to the study of the Kala chakra, Vyákaraṇa, and Vichara systems of Buddhism. The Jonang sect had its origin at Phun-tsholing. This school being very different from other schools in its peculiar theories, was considered by its enemies to be a heretical innovation. Formerly

Phuntsholing Jong was the seat of Dolgon Phagpa, the spiritual guide of the Emperor Kublai. The subjects under the jurisdiction of Phun-tsholing Jong and some of the subjects under Shikha Samdub-tse (Shiga-tse) became devoted to the Jonang school, and followed its ritual. The Jonangpa school having flourished, the reformed school was to some extent eclipsed by it, when great calamities befell the Government of the Grand Lama. During the hierarchy of the immediate successors of the Ngag-wang Lossang Gya-tsho, and particularly at the time of Buddha dhara and other Buddhists, great injury was being done by the followers of the Jonang school. Now-a-days the Gelugpa school is making rapid progress there.

To the south-east of these monasteries (Phuntsholing, Ngamring, &c.), in lower Tsang, lies the great monastery of Tashi-lhunpo, founded by Gyal-wa Gedundub. There Buddha Amitábha in human garb, holding the designation of Panchhen Tham-che Khanpa, has been residing for a series of generations. Numerous and most wonderful and sacred objects, collected and constructed with gems of the first water by the immaculate incarnations of the Panchhen, exist in the monastery of Tashi-lhunpo, which also contains the gilt tombs of the successive Panchhen, the religious robes of the former saints of India, China and Tibet, with their ornaments, dresses, the six sacred letters "*om ma ni pa me-hum*" carved out and written by Gedun-dub, &c., the value of which in the eyes of believers is immense. In the vicinity of Tashi-lhunpo, to the north-east, lies the newly-built palace of Kun-khyab-ling (erected by Pan-chhen Tanpai Nima). In the same direction, in the suburbs, lie the fort called Samdub-tse, erected by Deba Tsangpa in the first part of the 17th century A. D., and the town of Shiga-tse, which is a place of much trade. In the neighbourhood of Tashi-lhunpo there are several petty religious establishments, hermitages, and cells for recluses on the hills, together with groups of populous villages. To the west of Tashi-lhunpo (half a day's march) lies the monastery of Narthang, anciently the seat of many sages and learned men. Now-a-days it is decaying, and the number of its monks is on the decrease.

Narthang contains the block-prints for Buddhist scriptures, such as Kahgyur and Tangyur, besides several other objects of sanctity. To the east of Tashi-lhunpo, at a distance of half a day's ride, is situated the fort of Lhundub-tse in the Panam district, within the jurisdiction of which falls the great monastery of Shvalu, also called Serki Tsug-la khang (golden shrine), built in former times after the Chinese fashion. It contains numerous objects of religious sanctity, such as symbols, religious writings, chaityas and images called *tansum*. In its neighbourhood are several hermitages. The interior of Panam Jong is said to contain the dwelling of a certain demon. It is surrounded by several ramparts built of stone, in consequence of which the fort is considered impregnable. To the east of Panam, in Upper Nyang, lies the third city of Tibet, called Gyan-tse, which is a place of considerable trade. It was formerly the capital of *Situ* Rabtan kun ssang, and called Gya*l*-khang-tse. It contains the well-known shrine called Palkhor-chhorten, also Gomang Gandhola-chhenpo, built by king *Situ* Rabtan. The great monastery attached to it, called Pa*l*khor chhoide, contains eighteen different religious establishments, such as Gelugpa, Ningma, Karma, Sakyapa Dukpa, &c. Within the jurisdiction of Gyan-tse Jong there are several other monasteries belonging to different schools, such as Chhoide Dechan belonging to Ri-khor-chhosga, and several hermitages; and the estates of many nobles lie in the Gyan-tse district. The largest estates belong to Shape Doring and Phala. The city of Gyan-tse contains a large population. It formerly contained the seats of *Tertons* (discoverers of Tantrik scriptures) headed by Ngah-dag-Myang. To the north of Tashi-lhunpo, in the valley of the Tsangpo called Tsang-rong, lies the grand temple (hermitage) called Wensa Chhoikyi Phodang, built by Gya*l*wa Lossang Tondub. It contains many religious objects collected by that learned saint. The Buddhist devotees observe many wonderful figures and sacred symbols on the surrounding rocky precipices and hills. Not very far from it, and to the south of Tashi-lhunpo, is the hermitage of the saint Chhoikyi Dorje, called Garmo Chhoi Jong. There is a small fountain which contains water of wonderful efficacy. It is said to have sprung up miraculously. Besides, there are seen the *Lingam* of Mahádeva and Deví, all miraculously carved in rock. On the north bank of the Tsangpo, opposite to Wensa, are Ho-Yug and Shang. The latter contains the monasteries of Dechhen Rabgya and Gahdan Chhoikhorling, all of which belong to the Gelugpa school. Shang also includes Namling monastery and the seat of the learned saint Khyungpo of olden times, as well as the shrine of spirits built by King Tsang-tsan Dorje Ligpa, which has many miraculous things in it. The people of that town, owing to the agency of spirits residing in it, are possessed of great strength and can perform wonderful athletic feats.

To the east of Shang, in the eastern Tsang-rong valley and the defiles of Tsang, lie Rinchhen Púngpa Jong, the castle of Deba Rinchhen Púng of historic fame, Chyam chhen Choide (monastery) and the village of Thob-gya*l* (the birthplace of the late Tashi Lama Panchhen Rinpochhe). The last contains several religious establishments, the principal of which is the Bon monastery of Shendarding. In this division of Tsang-rong formerly many famous Lamas and great personages were born, and it contained the hermitages of many a saint, but it contains few villages and an inconsiderable area of arable soil.

To the south of Gyan-tse and Panam Lhundub-tse-Jong, after crossing a group of hills, you reach the district of Rhe (Sre*d*), which contains the monastery of Pa*l*dan Rhe Gyupai Tva-tshang and the Jong called Rhe Rinchhen-tse Jong and several villages which dot the banks of the river Rhe-chhu. There are also a few petty religious establishments, such as Ngorpa, &c., belonging to the Sakyapa school. To the east of Rhe Nang (a part of Rhe district) lies the large village of Pholha, the birthplace of King Miwang Pholha, which contains several petty villages. To the south-west of Tashi-lhunpo, after crossing a range of lofty hills called Kyingkar-La, you reach the district of Tinkye Jong, which contains a fort with a prison (Tsan-Jong) and a monastery situated in the middle of a lake. To the south of this district, in the midst of the black mountainous region which intervenes between India and Tibet, lie the territories of Mon Dajong, called Sukhem (Sikkim) by the Indians. The Sukhem people, though speaking a dialect of Tibetan, mostly follow the customs and manners of the Indians. Directly to the south of Gyantse, after passing Khangmar and other places in three marches, and crossing a high mountain range, you reach Phagri Jong, an outpost of Gahdan Phodang (Lhasa Government). To the south-east of Phagri, not at a great distance from it, lie the territories of Lho duk (Bhutan).

From Upper Nyang, after crossing Kharula and the minor groups of hills (which are personified as the Demon Kang-ssang and his retainers), one reaches the district of Yardok (Yam-do), which adjoins Phagri to the south. Yardok district contains Yardok-Yumtsho, one of the four great lakes of Tibet. In the winter season, from beneath the frozen depths of the lake, is constantly heard a thunder-like roar, which according to some is the cry of sea-lions, and according to others the roaring of the wind. The fish of this lake, though very small, are all said to be of equal size. This is said to have been caused by the powerful charm of the sage Dukpa Kungah Legpa. The truth of this story is questioned.

In Yardok there are three places of note, *viz.*, Yardok Taglung, Duk-Ralung, and Samding. The last monastery, founded by Botongpa, is presided over by Dorje Phagmo. Beside it there are some other religious establishments of different schools. Now-a-days most of these have adopted the Ningma theories. In Botongpa's monastery the spiritual incarnation of Botong chhogleg Nangya*l* continues. It also contains an incarnation of Dorje Na*l*jorma (Dorje Phagmo). Not far from it are the little towns of Pa*l*de Jong and Nankartse Jong. At Nankartse there is the monastary of Gur, which contains a javelin used in subduing the twelve enemies of Buddhism. Pilgrims see this javelin. The Digumpas are related to have been one of the twelve enemies mentioned above. The sage Potopa observed that the Digumpas did not deserve that opprobrium.

To the south of Yardok there is a large lake called Phag-tsho. Past Tsangrong you come to some monasteries, noted among which is Tsang Nam*s*gya*l* Detsha*l*, which adjoins the province of U. Here also are the estates of the Shapés born of the family of Thonmi Sambhota, as well as the birthplace of the latter, called Thonmi. To the east of these, in the province of U, lies the district of Kyisho, which is divided into two portions, called upper Kyisho and lower Kyisho. Lower Kyisho adjoins Tsang. Here lies the seat of the famous saint Dubthob Thangton, called Pa*l*chhen rivo, together with 108 religious establishments. Towards the northern hill ranges are situated Mon-chog Gonpa (the seat of Rinchhen tsondu), Ri-tsar chhoikorling (a Gelugpa monastery), and several other monasteries (Chhyagchepa) and convents. To the east of these in the neighbourhood of the confluence of the Tsangpo and Kyi-chhu (the two rivers of Tsang and U) lies the town of Chhu-sul Jong with several adjoining villages. To the east of this, at a distance of half a day's march, is the large village of Jang, where annually during the spring and summer many learned Lamas congregate to discuss on the Tshan Nyi*d* philosophy. To the east of Jang are situated the monastery of Tagtshang rawa-Toipa and the hermitage of that most learned and illustrious Lama Longdo*l* Lossang, who is believed to be the reigning emperor of Shambhala. Rawa Toi and other ancient monasteries which formerly held different doctrines, such as those of the Sakya, Ningma, Karmapa, Dukpa, Kahdampa and Gelugpa schools, have now turned to Gelugpa institutions, as now-a-days the Gelugpa school includes the doctrines of Kahdampa and Tshan Ni*d* schools. So also the Digum, Tag and Ningma schools are about to make up their doctrinal differences. On the southern bank of the river Thakah of Jang is situated the temple called Husang Doi Lhakhang, built of stone by King Ra*l*pachan, which contains many sacred objects besides an image of Husang Jovo. Lately a large piece of turquoise was obtained from the ground of this monastery. Not very far to the east of Rawa Toi lies Nethang, which contains the temple built in the days of Atisha, that noble saint of undiminished glory, and his tomb and 'many blessings of his saintly heart.' South of Nethang, on the south of U-chhu, is Sangphur, the seat of the learned Lochava of Ngog, called Legpai Sherab-khupon. There also exists the self-sprung image (in which are said to be visible the veins and muscles) of Ngog Lodan Sherab, as well as an image of Dharmapála with a wonderful buckler made of rhinoceros hide.

In ancient time there existed a large congregation of the followers and pupils of Wu-tsha; but since the rise and progress of the Sera and Dapung monasteries it has gradually declined, and now it contains a few householder priests of the Sakyapa school, although in summer many monks bearing the title of *Kahram*, of Shar-tse Ta-tshang (Gahdan monastery), congregate there.

In the valley of the Sangphu lies the little plain of Myanam, called Sangphu mutig thang, after crossing which, if you go to the north-east, you come to a fort situated on a hill on the bank of the Kyichhu, which in ancient time was the scene of many chivalrous exploits. Its chief obtained military honours at the hands of many kings such as Tah, Dwoorhor, and Taiming. There is also the palace and fort of Nehu Jong, anciently the residence of king Situ Chyang Chhub Gya*l*tshan, of the Phagmodub dynasty, all of which are now in ruins and resemble the abode of *Tisa* (gandharva). To the north of these, on the north bank of U-chhu, not at a great distance from them and on one side of a hill, lies the monastery of Khyormo Lung, which formerly was a place of importance, being the head-quarters of the Tshan Ni*d* school. Now-a-days it contains a few Gelugpa monks. North of this lies the large tract of land called Toilung, which contains the Toilun Chhu ssang monasteries belonging to the Gelugpa school, and several old religious establishments pertaining to the Kahgyupa school. It also holds the estates of Deba Kyi-shopa and his Jong called Toilung Dechhen Jong, and the monastery of Magyu Ta-tshang, near which is a fountain called Chhumig Lung which annually in summer is visited by hundreds of monks and priests. On the north of this district are the great monasteries of Tshur Phu and Yang pachen, the seats of the illustrious sage Karma Bakshi and his spiritual sons, which contain many sacred images and symbols.

In former times these monasteries were very rich and famous, but subsequently some of the incarnate Karma Lamas, out of jealousy having tried to injure that immaculate school of Rivo Gelugpa which had adopted the stainless doctrines of the son of Ikshaku and Rathika (Buddha), they were doomed to fall. Again, being displeased with the conduct of Chhoidub Gya-tsho and other red cap Lamas, Emperor Chhing-Lung converted the monastery of Yangpachen into a Gelugpa institution. From the valley of Toilung, if you go a little to the north-east, there in the valley you find a religious establishment called Gahdong or Devachan, belonging to the Tshan ni*d* school, which has now become the residence of some householder priests. There also exist the caverns where Tsongkhapa used to meditate and sit in yoga.

To the east of this place lies Shing Dong kar, where there is a fort erected by Doba shi tse pa of Tsang, close to which there are the buffaloes of Tam-chan Chhoi gya*l*, the monkey of the goddess Pa*l*dan Mag dsorma, the bear of the Demon Khetrapala, the buckler of Nachhung, and the footsteps of Khorsum carved on stone. Although there are different stories connected with the origin of these footsteps, yet the most reliable accounts state that these were produced at the time when Regent (Desri) Tsangpa, in order to promote the interests of the Karma school, tried to injure the school of Tsong Khapa.

Thence travelling eastward you arrive at a lofty hill called Ma Rirab Chyam or Rivo Gephel, considered very holy, to the side of which is situated that great and powerful monastery called Pa*l*dan Da pung, famous all over North Asia. It formerly contained seven (Ta-tshang) monk establishments, but now-a-days the number has gone down to four, namely, Gomang, Losal Ling, Deyang and Ngapa, Ta-tshang, with monks numbering over seven thousand. In the grand hall of congregation in Dapung is the huge image of Maitreya, called Chyampa Thongdo*l*, besides many other images and sacred objects, among which the manuscripts of the Indian saint Chandra Gomi, the image of Chanrassig and the tomb of Rva Lochava are the most noted. Here is a small palace belonging to the Dalai Lama called Gahdan Phodang. The image of vajra Bhairava standing in the hall of the Tantrik congregation (Ngagpa Ta-tshang), which is of great sanctity, is said to emit a brilliant lustre. In Dapung great attention is paid to the teaching of the Vinaya, Abhidharma, and Madhyamika systems of philosophy and Prajña páramitá scriptures. The Tshan Ni*d* Ta-tshang, with the exception of its liturgy and ritual, does not practise much of Trantrikism. At a short distance from Dapung is situated the castle called Na-Chhung, which is the sanctuary of the prince of oracles. The great king of genii, Pehar, resides here inside a great image. Sometimes he is manifest in the person of the presiding priest. Then proceeding eastward, along the margin of a marshy tract called Dambu chan ki-tsho, you come to the second Tu-ssin (Potala) of Gya*l*-Wang Thamche Khyanpa, the all-knowing victor, and the far-famed city of Pa*l* Lhadan (Lhasa). The city of Lhasa, though it cannot bear comparison with any of the large towns of Aryavarta, is yet the largest city of Tibet. In the centre of Lhasa is the shrine of Shakya Buddha, three storeys high. The famed image (being the representation of Shakya Si*m*ha while he was 12 years of age), was brought from China by the first Chinese princess married to King Srongtsan Gampo. The shrine also contains the self-sprung image of Chanrassig, the image of Maitreya Buddha, in the interior of which are precious and sacred inscriptions of King Kriki of Panchala, the image of Tsongkhapa, the image of Sri*d*-sum Gya*l*mo (goddess unrivalled) known in India by the name of Sachí Kámini, and numerous other sacred objects, a description of all of which will be found in the work called *Lhasai karchhag*, compiled by Jamyang Gah-wai She-ngen. In Lhasa there are also several Tatshang such as Meru-shi-de, &c., the residence of many landlords and nobles of Tibet. It is also the centre of the North

High Asian trade; where merchants from India, China, Kashmir, Nepal, and Bhutan meet. Travellers from Tsang, U, Nahri, Amdo, Kham, Hor and Mongolia always come to Lhasa. At a distance of half a mile from the city, to the west of it, stands the famed palace of Potálá, the residence of Chanrassig, the Lord of the world, who in human shape is incarnate in the Dalai Lama. Potálá is eleven-storied, white in appearance, and was erected by King Ssongtsan Gampo. There also stands the Red palace (Phodung Marpo), built by Regent Desri Sangye Gyamtsho, thirteen storeys high, containing the image of Lokeshvara, the golden tomb of Kongsa Ngapa (5th Dalai Lama), called Dsamling Gyen—the ornament of the world. There perpetually reside the successive incarnations of the Dalai Lama. To the south-west of Potálá, and very close to it, is the famous hill called Chagpoiri (sacred to Chhyagna Dorje or Vajra Páṇi), on the top of which is the religious establishment called Chagpoiri Vaiduiya Ta-tshang, containing a college for training physicians. To the west of Chagpoiri is situated the hill called Dari, sacred to Arya Manjusri, on the top of which is situated the castle-like temple of the Emperor of China, called Dalha Yungdung Raja. In the suburb of Lhasa and Potálá is the residency of the Ampan, who is posted in Tibet to protect the interests of the Grand Lama. There are also the monasteries of Tangyeling, and other religious institutions, the heads of which become incarnate successively to defend the kingdom of Tibet. Groves and gardens, fountains and wells, lakes and meadows, abound there. To the north of the city of Lhasa, at a distance of about a furlong, are the battle-field and fortifications which were the scene of Lhabssang's defeat by the troops of Oro*d*-Jungar. The site known by the name of Dasi thang is partly occupied by the Chinese troops under a captain called Táloye. Going to the north of this field you reach the great monastery of Sera Theg-chhe ling, in which formerly existed four Ta-tshang (schools), but now-a-days they are reduced to three, namely, Chye Ta-tshang, Ma Ta-tshang and Ngagpa Ta-tshang, with a total monk population of about 5,000. In the grand congregation hall (Tshogchhen) of Sera is the great image of the eleven-faced Chanrassig (Chuchig sha*l*), in the interior of which are sacred inscriptions of Gelongma Pa*l*mo, &c. In the congregation hall of Chyepa Ta-tshang of Sera are the images of Pa*l*-Pa*d*ma Sangtagpo, possessed of miraculous properties, and the club-like pin (Phurbu) obtained by Dubthob Dah chhya from underneath a cave. In the hills behind Sera and Dapung are situated Gephel retoi (hill cavern), Tagri retoi, of Sarma and Ñingma schools, the sacred rock Kha chhu-ssang, Phurbu chog, east and west Kehu tshang, Sera-tse, Rukha-Tag (rock), Khardo, Dichhung monastery, Ñangtan Phug, Guru Gonpa, Sephug, Panglung retoi and Rigya monasteries and religious institutions, as well as Sera Chhoiding, the hermitage of Tsongkhopa. If travelling along the northern bank of U-Chhu you go eastward, you come across a forest, after crossing which you arrive at a hill called Tagyer, in the waist of which was anciently situated the hermitage and cell of Atisha, the recluse cavern of the great Acharya Pa*d*ma sambhava (called Daphug) and the cavern of Yoga of 80 saints *(Dubthob)*. There also exist in that place the image of Chanrassig, from whose fingers nectar is said to have flowed; a mani (gem symbol) of white stone, said to have been self-sprung from a black stone bed; an image of Tárá, self-sprung also, and of white stone out of a blue rocky bed; the image of Jambhala (Kuveras), Rigchyema (Vedamati); the image of Dubtbob-Birvapa and the hand and foot-marks of many ancient holy personages. There also is Yerpa Chyamchhen, one of the four great Maitreyas (Chyamchhen) of Tibet that poured nectar from its hands, the temple and the image of the matchless god Pa*l* Lha Shiva, and many wonderful sacred objects. There in former times existed a large congregation of priests and monks who followed the Kahdampa school. Now it has been converted to the Gelugpa school and contains about 300 monks. Here annually in summer the Paldan Toigyupa monks hold religious conferences. In the vicinity of it, on the southern bank of Kyichhu, are situated the monasteries of Tsha*l* gung thang and U-ling, the seats of Lama Shang Tshalva. These are said to contain many objects of sanctity. Here formerly existed sáng nag gyupai Ta-tshang, which has now been converted to the Gelugpa school. To the east of U-ling, at a distance of half a day's march, existed Dachhen Jong, formerly the possession of Deba Kyi-sho, in the neighbourhood of which existed Sang Ngag khar Ta-tshang and the image of Maitreya constructed by Khadub Rinpochhe. Then if you go further east along the northern bank of Kyichhu, you will come across the shrine of Ngangonphug, to the east of which, on the south bank of U-Chhu, there is the hill called Wang Kur ri, on which stands the grand monastery of Gahdan *nambar gyal wailing*, founded by the great reformer Shar Tsongkhapa Lossang Tagpa. Gahdan formerly possessed three Ta-tshang, but now it contains only two, *viz.*, Shar-tse and Chyang-tse, with above 3,000 monks.

Gahdan contains the *chhorten* which is the tomb of Tsong-khapa, his throne famed as gahdan (golden chair) *ser thi*, his cell called Hosser phug, the image of Shakya Simha called Thub-tshu*l* thim-ma, constructed during Tsong-khapa's ministry, the image of the imaginary hero Thopai dumbu char called Pah-o-gah-tshonma, the images of Yamántaka, Mahákála, and Kála rupa, constructed under the direction of Tsong-khapa, as well as the *Mandalas* of Guhya Samája and Sambara, also constructed in his time. Around the great monastery are the following :—The place where Tsong-khapa discovered a conch shell, the foot-mark of Mudgalayana (one of the principal disciples of Buddha), the guard-post of the monkey that guards the hidden religious treasures called *Ter*, the residence of Thonpa hermit, who was possessed of the faculty of suspending his animation (Gog-Ñom), the images of Rig-sum Gonpo, the hand and foot-marks of Chhasa chhoi-kyi-Senge, Tsong-khapa's head-dress, rosary, &c., the foot-marks of the Bhutanese saint Dukpa-kun leg, besides many *chhortens* which are said to be of miraculous origin. The image of Tsong-khapa and his self-sprung bust are to be seen in the cell where Tsong-khapa obtained sainthood, and the hand and foot-marks of Tsong-khapa himself. To the north of Gahdan lies the large district of Phan-yul, where exist the ancient temples and monasteries of Kahdampa school, these being the seat of the Sharbu line of Lamas, among whom were Tenshar Pumpa, Gewai Sheñan, Phenyul Lhakhang, the seat of Gesho lang-ri-thangpa. There also exist many other monasteries such as Chhoi-khor-ling (Gelugpa), Phen-yul Nalendra (Sakya school), &c. After passing these, if you go to the north-east, you come across a high hill called chhagla, which crossed, you reach the monastery of Chyang Tag lung, where exists the tomb of Dom (Brom) tan Rinpochhe, the illustrious disciple of Atisha. There on the face of a lofty precipice stands the recluse temple *(retoi)* called Siligatshang, the seat of Gya*l*wa Goitshang. To the north-east of that place lies the Rong district, where there is a Jong called Phudo Jong, and several petty hamlets. North-east of Rong lies the extensive country in which is situated the great monastery of Radeng founded by Dom Rinpochhe in accordance to the prophecy of his great teacher, the immortal Atisha (Dipankara Sri-Jñána). Radeng contains many sacred objects, symbols and scriptural inscriptions on paper left by Atisha, the image of Jam pal dorje of Guhya Samaja Tantra, and the image of Maitreya constructed by Atisha himself. Near the south-west wing of the monastery of Radeng is the temple of Gonkhang and the tombs and images of the abbots of the Ka*h*dampa school. In the neighbourhood of Radeng there are several fountains which are said to be the abodes of different demi-gods, such as Nágas, Yakshas and Rakshasas; also the large grove of *sugpa* (juniper) trees said to be planted by Domtan. Radeng, according to the book of prophecy called Ka*h*dam legbam, once became the seat of learning as well as the residence of such illustrious personages as Domtan and his worthy successors, in consequence of which its sanctity is great. It formerly contained a large number of monks and Ta-tshañgs and religious authors, but subsequently when the Digung (Digum) hierarchs became powerful, this old and pure religious school, which had turned out many excellent scholars, began to decay. It has now been converted into a Gelugpa institution. In the termination of lower Phudo (district), in the upper U division, is situated the Digung tsha*l* monastery founded by Digung Chhoije Kyobpa Rinpochhe, with the sub-monasteries of Rigañg and a Jong called Digung Jongsar. Here ruled the successive incarnations of Gyalwa Diguñg and his spiritual sons over an immensely large number of monks and Buddhists.

North of U and Tsang lies the extensive hilly country of Dokyul (shepherd land) divided into several parts, such as Nag-tshang, Namru, Nagchhu, Yangpa chan-de, Chyang rig de, and four De of yak herds inhabited by numerous tribes of pastoral people called Hor-de. The name Hor evidently is a corruption of the Chinese word Hwu-hoi, meaning northern, and which also means a cover or tent. In this vast Dokpa country lies one of the four great lakes of Tibet called Nam-tsho chhyugmo (Tengrinor), and the lofty snowy range called Ñan-chhen thang la kangri, considered as the wonderland of Buddhist pilgrimage.

If you go southwards (down) from the confluence of the great Tsangpo and U-Chhu (Kyi-chhu), you will arrive at Gongkar Jong, a large fortress with a prison, in the neighbourhood of which lies Gongkar Chhoide (a large monastery), the seat of Gongkar Dorje-danpa of the Sakyapa school, with some hamlets around it. In the uplands of Gongkar are Dechhen Chhoikhor (a large Dukpa monastery), and several smaller monasteries and convents. If you go a short distance northward from this place, you arrive at the Sakyapa monastery of Kyisho-rawa, ma, in the vicinity of which there are a few hamlets. Travelling north from U-Chhu for about half a day, you arrive at the great Tantrik monastery of Dorjetag, which contains the incarnation of Padma Thinle and about 400 ordained monks. Hence following the Tsangpo (which flows near it) south-eastward, you arrive at some of the Gelugpa monasteries, such as Do*l*-sung rab ling, &c., in the neighbourhood of which there are several villages with some trade. To the south of these lies the monastery of Chyampa ling with a lofty *chhorten* containing 108 temples and resembling Pa*l*khor Chhoi de Chhoikhor of Gyan-tse. Not far from these lies the great Ningma monastery of Mindolling with a large religious establishment.

Travelling eastward of Dorjetag (mentioned above), after a full day's journey across a sandy plain, you arrive at the most ancient monastery of ssan-yang *migyur Lhundubt Sugla Khang*, ordinarily called Samye. It contains four upper compartments called *R*tse ling shi and eight smaller compartments called Ling then-*g*ye. It was built by King Thisrong deu tsan under the direction of Padma-Sambhava after the model of the great monastery of Otontapuri of Magadha in the first part of the eighth century A. D. A description of its contents is given at length in Pama Kah thang. From Samye travelling southwards, after crossing the Tsangpo to its south bank, you reach the town of Namsreling, to the south of which lies Tse-thang (Chethang of English maps), a place of some trade, with a monastery called Tse-thang Chhoide. Going to the south-west of Tse-thang, you find yourself in the valley of Yarlung, where there are many places of ancient fame and sanctity, such as a large *chhorten* called Gyanthang Bum-pa, and two others, Tshe-gya*l*-bumpa and Theg Chhen bumpa, Thadug Do*l*ma-Lha khang (temple), Tsanthang Chandan Yui Lha khang, and the most ancient palace of Yambu Lagang, Yarlung She*l* tag, the Yoga cavern of Padma Sambhava, &c. She*l*tag (the crystal rock cavern) is said to be possessed of the wonderful capacity of holding within it as many pilgrims as may gather there to pray. In Yarlung there are many monasteries and religious establishments, such as Thangpo chhe, Chhyong gya rivo dechhen, Rivo chhoi ling, and several Jong (fort), such as Chhyong gya jong and Yarlun Nedong jong, together with numerous towns and villages. Travelling to the east of Samye you arrive at a small tract of land which is the seat of Gya*l*-sre Rinpochhe, called Hon chhoi ding. To the left bank of the Tsangpo is situated the Ngahri Ta-tshang monastery, to the east of which at a short distance is the well-known monastery of Lama Je Phagmodub, called Densathi*l*, which contains that illustrious Lama's image, an object of great sanctity.

At Densathi*l* there are eighteen silver tombs of the eighteen successors of Phagmodub Lama Rinpochhe, together with eighteen Kahgyur collections written in gold, and the eighteen kinds of precious stones and metal objects of great sanctity. This old monastery once rivalled the monastery of Radeng, but now-a-days the owners are said to use them as shelter for cattle. From this place, if you go further east along the bank of Tsangpo, you arrive at the hermitage of that saintly nun Labkyi Donma (of the Shichyo school), called Ssangri khang mar, which contains an image of the illustrious nun. Then going northward you arrive at Lalung, where there is a monastery called Nam do*l* ling, erected by Hol kha jedungpa. To the further east is situated Chyan khang of Jing chhyi (chyamba). Proceeding further to the south-east you come to the recluse monastery of Ho*l* kha Samtanling, which was the scene of Khorlo Dompa's vicarage. Close to it is Ho*l*Khagarphug, the cavern where Tsong-khapa meditated with the object of attaining sainthood; leaving which, if you go to the south-east, you will arrive at the hill called Hode gung gya*l*ri, on the back of which are a recluse monastery called Ho*l* kha Chhoi lung, and the recluse cell of Tsongkhapa, built according to the description laid down in the Vinaya Law. There also are to be found the hand and foot-marks of Tsongkhapa, printed when he was practising physical austerities; the *Mandala* of stone on the surface of which there had miraculously appeared mystic writings when Tsong-khapa was miraculously visited by thirty-five Buddhist gods: the *Mani* figure drawn by his own fingers on the surface of a rock, as also the marks of his back and the drawing of his sash and raiment. Close to this are the places called Hol kha Chyambaling and Rinchhen ling. In the front of Hode Gungyal is another recluse hermitage of Tsong-khapa called Gyasog, where he saw the different moods of his father's countenance and was reminded of his birth stories. Close to Ssangri (mentioned above) are the towns of Hol kha Tag-tse Jong and some villages. Then going eastward, following the Tsangpo, you reach the monastery of Dvagpo Shadub ling and other places. Next crossing the Tsangpo, if you go southward, you come to a place called A-Yül, where there are several villages and some Gelugpa religious establishments. In the tract of land which is situated on the north bank of the Tsangpo, facing to the south, there exists the monastery of Chhoi khorling, founded according to the prophecy of Dumlegbam, which also contains a small palace belonging to the Dalai Lama, and some sacred objects. Not far from these is La-tsho lake (believed to be the heart of Paldan Lhamo, or the goddess Kali), in which the reflected images of different objects are seen. Lower down to the south of Yardok, and upward to the south of Yarlung, is the country called Lhobrag, where there are the birthplace of Marpa, the castle-like (nine-storeyed) temple called Dorje tsogpai sra khar erected by Mila rapa, and the image of Lakyi Dorje the saint; the last, when walked round and touched, relieves leprosy. There also are the Tovogonpa, the seat of Lakyi Dorje, and the temples and monasteries built by holy personages born of Shupoirig (race), and the tower called Lhobrag Duojong, with several villages and pastoral Dokpa tribes. Lower down to the south of Lhobrag is the tract of land called Nal, where in ancient time there were several monasteries and temples with a large population, but now it is in a state of decline. Here also were the seat of Rachhungpa and some monasteries of the Kahgyupa and Gelugpa schools. There are now some Lamas and an incarnation of Kyura Tham cha khenpa of the Kahgyupa school. To the south-east of Lhobrag lies Mon tshona, to the south of which are the districts of Montawang and Tamon. To the east of these lies the district of Chya Yul, containing many villages. The upper portion of Chya Yul belongs to Tibet and the lower or southern part to the Lepa savage tribe. In upper Chya Yul are the monastery (founded by Ami chyanag Tantrik Lama) and the seat and palace (of Phodang Yank tse) of Gewaishenen chya Yulpa, with a fort attached to it. If you travel further to the south-east, you will arive at that holy place of pilgrimage called *Pal* Tsari (Tsvari).

If you travel to the east of Dvagpo shadubling, you will arrive at the Dvagpo country with Namgya*l* jong of Dvagpo and some minor places with a tolerable population, and then to the south of the Tsangpo you will find the Gelugpa monastery of Gahdan rabtanling (Dvagpo) and the town of Dvag Gampo, where up to the middle of the 17th century existed the descendants of Je Gampo, who for their disloyal character were extinguished by the Orod Mongol chief Tshering Tondub and his troops. At present there exists an incarnation of Je Gampo, but no descendants of his.

To the south of these there is a hill called Dvagpo Gongmola, having crossed which you arrive at a plain called Tsari Khi*l* khor thang, where there are several petty hamlets inhabited by a people called Lalo *mikya deng.* Tsari being believed to be guarded by *Khadoma* (Dakinis), or aerial goddesses, there is a succession of human *Khadomas.* In every 13th year (generally in the ape year) pilgrims, about 10,000 in number, travel together to visit the sacred places of Tsari. Lonely travellers, nay even large bands of pilgrims, for fear of the Lalo savages, never venture to visit Tsari. The Government of Gahdan Phodang (Lhasa) sends presents to the Lopa and other savage tribes with a view to prevent raids in Tibetan territories and molestation of travellers by them. The Lopa and other savage people are said to have been brought to terms by the agency of certain *Khadomas* or fairies. The pilgrims who travel in a body, following the course of the stream af Kyi*l*khor Thang, descend to the valley, and there after crossing nine mountains, nine ravines, nine torrents, nine bridges, passing along precipitous and extremely narrow paths and threading steep precipices, and venturing through the extremely difficult and dangerous narrow passage called *Chyadyl* and *Chyidyl,* at last arrive at the place of pilgrimage called Dvagpo Tsari Thugka. Then descending down a deep ravine and ascending along the rapids of Chyayul, they arrive at Tshoi-ssamdung, which is said to be the limit of Buddhist pilgrimage. This dangerous journey takes a fortnight of hard travel. In this kind of pilgrimage, anciently, Tibetan travellers and pilgrims never used to embark, but subsequently Lama Yeshe Dorje, the chief disciple of Je Lama Phagmo dub, happened to go there for the purpose of making austere meditation, from which time the way to it has been opened and pilgrims commenced to frequent it. The summit of the mountain of Tsari remains perpetually covered with snow. The country is clad wilh thick forests. Beneath is said to exist the abode of a Nága-demon named Tsva lu-du Dorje. Pilgrims who succeed in making a pilgrimage thereto are said to be able to escape at once from mundane existence and misery. The wild animals of Tsari, and beasts of burden as sheep and goats, when conducted to Tsari are, by virtue of going there, said to have images of deities and sacred writings miraculously engraven on their horns and bones. A certain author remarked: "Glory and fortune be to that great saint who performed yoga in Tsari."

Tsari being considered as the sacred heart of the Tantrik deity Khorlo Dompa, the Indian Tirthikas designate Tsari-dvagpo as the land of Ulanga *strípurusha*, where exists the real Mahádeva. The Indian Parivrajakas and Tirthikas wander all over Kámarupa, Assam and Nága land in search of their god (Mahádeva). It is not known to them that Tsari is not the real place of pilgrimage of the Tirthikas. From Holkha and upper U if you go to the east and south-eastward, you arrive at Nangpoiyul, where formerly existed several thousand habitations, but now-a-days the country has been deserted, and scarcely more than ten houses exist. This is probably caused by the place being on the highway.

Lower down Nangpo is the district of Kongpo yul, where exist the ancient monastery of Buchhung serkyi Lhakhang and other temples and monasteries of the Chhabkar and Chhabnag period of Bon religion, now converted into Gelugpa institutions. Here are also religious establishments of the Sakya, Ningma Karma Dukpa and other schools, as well as Kongpo, Tagsum Jong (fort), besides numerous villages with Bonpo populations, the Bonri mountain, and the place from which Terton Jah tshon discovered some sacred volumes.

III.—GREAT TIBET.

To the east and north-east of Tibet proper (U and Tsang) lies the country of Great Tibet, comprising Amdo, Kham and Gang. The following are the principal divisions of Great Tibet:—Maja ssabmo Gang, Tshava Gang, and Pompo Gang, constituting the upper three Gang, and Markham Gang, Minag Gang, and Yarmo Gang, the lower three Gang; comprising altogether six Gang or divisions. To these may be added the four great mountainous districts called Rong, *viz.*, Tshava Rong, Sangnan Rong, Nag Rong, and Gya*l*mo Rong, with smaller Rong, such as Minag Rong, &c.

From Kongpo if you travel eastward, after crossing a lofty mountain, you arrive at the place where upper Kham commences. This portion is called Poboi Yul. This country, according to the tales of Lingje, is mentioned as Pharssug Athai Rong. It contains Na Pa*d*ma Koi, where Padma Sambhava is said to have mysteriously performed *yoga*, Pobo Chhu dah monastery of Gelugpa school, and several Ningma religious establishments. The chief of Pobo-land, who is independent, is called Dehu Kanam. To the south-west of Pobo Yul lies *Lalo*, or the savage country. On its east lies Tshava Rong, which is under the Lhasa Government, and annually sends considerable tribute in kind. Its chief town is called Tshava Jo Gang Jong, besides which there are other smaller towns such as Sang ngag chhoi Jong, and villages with considerable populations. To the east of Tshava Rong are the smaller districts of Jira, Dsui, Jang &c., to the north-east of which lies Gya*l*thang. East of Gya*l*thang lies Mili, to the south-west of which, and also to the south of Gya*l*thang, is Lalo, which is inhabited by a wild tribe.

To the west of Gya*l*thang and north of Sompho land, near Jang, is Na-khawa karpo (white snow), well known in Tibet and China as a place of great scanctity. In the confines of Jang and China is a place of sanctity called Richya kyang. In Gya*l*thang there is the temple of a very sacred image called *Gyal waringa*, as well as a monastery called Gya*l*thang sseru Gon, belonging to the Gelugpa school. In Mili and Gya*l*thang there are several religious establishments belonging to the Gelugpa and Kunchoi Tsangpa schools. To the south of the above-mentioned districts lies the Yunan province of China and to the east is situated the Gya*l*hin district of Ssitwan. If from Ñang, after crossing a mountain pass, you travel eastward, you will reach Kham Lhari, to the north-east of which lie the towns of Chagri Pa*l*bar Gya*l*ton, Khyung kar, Khyung nag and Khyungser and numerous villages and Dokpà tribes, all of which are subject to the Government of Lhasa. In the Khyungpo districts there are eight Gelugpa establishments and several Bon institutions, such as Khyungpo Ting chhen, &c. Again, from Kham Lhari if you travel eastward after crossing a mountain pass called Shar Kang Lon, you come to another lofty mountain called Tshava gang La, after crossing which you arrive at the Ngu*l* chhu (silver river), on the left bank of which is situated the great monastery of Rivochhe, belonging to the Taglung school, which contains a monastery and grand temple with numerous scriptures and sacred objects. This monastery was formerly the seat of a famous Lama called Sangye yar-chyon, who belonged to the Kahgyu school. There are two incarnations of Kahgyu Lamas and a descendant of a lay Kahgyu Lama. To the east of this place, at the confluence of Jachhu and Ngam chhu, is situated Chhabdo gonpa, where Phagpa Lha Yab sra (two incarnate Lamas of high repute and power) preside over above 2,000 monks. There are numerous villages, scriptures and sacred objects. The monastery is rich. Lately Kahgyur block-prints have been established there. The monastery is said to be guarded by a demon called Ku wantsan or *Lokapála*. Chhabdo is a powerful state owing allegiance to the Dalai Lama. The incarnate Lamas occasionally visit Lhasa and Tsang, and are received with great respect and preparation there. In Chhabdo there are a few scholars of the Tshan Ñi*d* philosophy.

If you proceed further east, you come across a tribe called Tagyab. Here is a huge rock the top of which spreads like a canopy. In Tagyab yul there are two monasteries called Magon and Bugon, two incarnations of Legpai Sherab and Lodan Sherab (spiritual father and son,), designated by the title of Chhe-Tshang and Chhung-Tshang, who preside over a large number of monks, and also several villages constituting a large district. This monastery formerly belonged to the Tshan Ñi*d* school, but has been converted into a Gelugpa institution. The Tagyab tribes are greatly devoted to the Gelugpa school. From Tagyab yul if you go further east, you reach Mar Kham, where there are some monasteries belonging to the Sakyapa and Gelugpa schools, and the ancient temple of Dolma Lhakhang erected in the days of Srongtsan Gampo. The people of Mar Kham, who are of strong make, are devoted to mischievous pursuits (robbery, &c.), and speak a dialect of Miñag. To the east of Mar Kham lies Kongtse kha, which forms the boundary of Tibet and China. To the east of Kongtse kha lies the Bah division (Batang of English maps), which contains the Bah chhoi dé (Gonpa) and Goj Jijé monasteries of the Gelugpa school and several villages. From Bahthang if you travel along the valley of the Dichhu river, you arrive at a (Rong) hilly country called Bahsangan, of which the whole population lives by professional brigandage and robbery. From Bah division going eastward you arrive at Lithang, where (in the neighbourhood of Bah) there is a place of pilgrimage called Kaburnanang, in which in ancient times there was a large Karmapâ monastery, on the site of which there is at present a small monastery called Kesar Gon khang. On its east side lies the Thub-chhen Chyambaling monastery of Lithang, containing 2,800 monks and many learned scholars of theTshan-ñi*d* school. There are also several large and minor monasteries among which the Samphelling monastery of the Gelugpa school is noted. The monasteries of the Sakya and Ñingma schools there are in a state of decline. To the north-east of Lithang lies Ñagrong (a very large district). The people of upper Ñagrong are professional brigands and robbers. The lower portion of Ñagrong is inhabited by Lithang and Miñag tribes. The tract on the right bank of the Ñgagchhu river belongs to the jurisdiction of the Lithang chief (under Chna). It contains a temple called Phod ang Ngatse, where the Indian Áchárya Pha Tampa Sangye (the founder of the Shichyepa school of Tibet) performed yoga for some time. It is said to contain the mark of this saint's back printed on the face of a rock.

From Lithang crossing the Ñgagchhu if you travel eastward, you arrive in the extensive country of Miñag, which contains the Miñag kah shi (Gonpa) monastery belonging to the Sakya school, and the Miñag Kye lí (Gonpa) monastery belonging to the Gelugpa school. To the north end of Miñag, in the vicinity of Horkhog, lies Thar thang, once the temporary residence of the Dalai Lama. Miñag belongs to Lhasa. To the east of Miñag lies Gya*l*mo Rong, which formerly was ruled by 18 chiefs, but at present it is divided into 13 chieftainships. They are Chagla, Wasi, Thokyab, Somang, Dsongag, Chog-tse, Tampa, Hoshi, Doli, Dati, Pabam, Gesi-tsha, Hwa Hwa, Len ṭsa, Rabtan, Tsanla, Gya*l* kha, and Donbu. The people of these places are very strong and stalwart. They are prone to depredatory pursuits, and are professional brigands and robbers roving over the whole of Tibet and the North Himalayan states, and are wild in their habits. The people of Miñag, Gya*l*mo rong, Mili, though they speak a corrupt form of the Tibetan language, possess very few virtues of the Tibetans. In Gya*l*mo Rong there is a very lofty range of mountains called Gyalmo mordo, and the cavern where the great Lochava Vairochana practised meditation, and which contains his hand and foot-marks.

To the south-east of Ñgagchhu lies Nagsho, inhabited by a Dokpa tribe. To the east of Ñgagchhu lie Atag, Dsamar and Sogde, Dokpa tribes. To the east of these lie Gégyé Dongpa, Dorshui Ling toima, (upper Ling), Perikhugah, Yoishni, Rogshni, Tagrang, Hothog, Gohutsha Longulchin, Na-tsho, Gehtse, and numerous Dokpa lands inhabited by various Dokpa tribes. To the south of these, and north of Chhabdo (Chhamdo) and Tagyab and Bah, lie the territories of the largest of Kham principalities, called Dégé or Kham Dégé. The Kham people arrogate to themselves a high position among the kingdoms of the north. According to them Tibet, divided into 13 divisions called Thikor chusum, and Kham, divided into 13 principalities called Phodang chusum, and China (containing 13 provinces), are most important among the great countries of North Asia. Within the principality of Kham Dégé there are many monasteries belonging to the Kahgyu, Sakyapa, and Ningma schools, such as Jâ.Dsogchhenpa (Gonpa) monastery, Shichhen (Gonpa), Payul Kathogpa (Gonpa), Situi Gonpa, and the monastery of Dégé King, but there is no Gelugpa monastery in Kham Dégé. Outside of Dégé, but in its neighbourhood, there are several tribes, such as Dan, Khog, Ga Khog, Lingbarma, Rañag, Rasod, in which there are many Gelugpa monasteries, such as Chhoi Khorling, &c. To the east of Dégé lies the district of Honknog, where there are five petty states, namely Khangsar, Massi, Taggo, Piri, and Tiho; besides there are the monasteries of Horgantse Gonpa, Taggo Gonpa, Tareo Ñatsho Gonpa, Ja Gonsar, and others containing large Gelugpa establishments.

To the east of Honkhog lies the petty state of Tongkor, after passing which you arrive at the province of *Dome Amdo*. The Kham people are straightforward in nature, very strong, martial, and loyal to their chiefs. In faithfulness and attachment they are far superior to other Tibetans. Devoted to the verge of bigotry in matters of religion, they are uncivil, harsh, and mischievous to strangers. To their acquaintances they show extraordinary fidelity, usefulness, and attachment.

To the east of Tongkor lie Dokhog, Jikhog, and Markhog, all three being included within Amdo. In Dokhog is the monastery of Dodubchhen Gonpa, which formerly belonged to the Gelugpa school. In Jikhog is the monastery of Jam thang (Gonpa), which belonged to the Jonang school till the extinction of that sect under the edict of the Dalai Lama. Markhog is the fatherland of the Golog Mussalmans (probably Tangyut of Colonel Prejevalsky). From there if you proceed further to the east for some distance, you will arrive at Machhu Pomra (the temple of a deity), situated on the bank of the river Machu, at the back of which is a lofty snowy mountain. There lepers are said to obtain a complete cure by rolling their bodies on the slope of the snowy mountain, and by drinking its glacial water. To the north-east of the great Machhu is Arig (brigand tribe) land, to the east of which is Jogetoima. To the south of Joge, in the neighbourhood of Gya*l* Rong, are the lands of five tribes called Nakhog, containing a tolerably large population. Both Arig and Joge are filled with a population of heartless brigands and robbers. To the north-east of Arig land, in the neighbourhood of lake Kokonor (Tshoñonpo), is situated the sacred place of pilgrimage, called Tagkartal jong, in a cavern of which there are said to exist many self-sprung Buddhist images, as well as some springs and small lakes. To some distance from it, and on the west, is the monastery of Ragya. To the south-east of Nakhog, within the jurisdiction of Ssetwan in the neighbourhood of Ssugpher, there are several tribes called Muge and Sarp, who speak a kind of Tibetan and belong to the Tibetan family. The lower Sarpas are not allied to the Tibetan family. To the north-east of Joge, not at a great distance from it, are a few Kokonor people. To the south-east end of those places, and far from the Chinese district of Helun, lies the district of Sangkhog, in which is situated the grand monastery of Labrang Tashi khyi*l*, the seat of the famous Lama Jamyan shepa Dorje. This is the best and largest of all Amdoan monasteries. Close to this monastery lies the celebrated rock called Gankyai Tagkar, which is said to be famed as the abode of *Khadoma* (fairies), and to contain many wonderful and supernatural images of saints. To the south of Sangkhog lies the lower Joge, to the south of which lie Chhog, Gor, Tsoi, Tsayé, Thebo, Ssam tsha, Khyágé, and other divisions and tribes. To the east of these, and bordering the Chinese district of Ssetwan, lies the large Tibetan district of Chone, which contains five large monasteries, and block-prints of Kahgyur and Tangyur.

The Choné people mostly resemble in dress and dialect the people of Bahthang, Lithang, and Gya*l* Rong. To the north of Labrang and Tashikhyi*l* lies a large (tribal) district called Rongpo, which contains many religious establishments, caverns, and recluse monasteries, such as Rongpo Gonchhen, &c. The people of Rongpo are of a dangerous character. They continually carry on disputes, and show great delight in fighting and bloodshed. The Bon Tantriks of this place exercise much power, and exhibit the efficacy of their mysticism. There are many orders of Bonpos. Both Rongpo and Nakhog are the largest and most populous of Amdoan districts. To the west of Rongpo lies Thikha, which is inhabited by a Tibetan as well as a Chinese population. It contains Jujo Lhakhang on the top of a hill (the Lamoi Dichhu), and several monasteries and other religious establishments. To the east of Thikha and Rikon, on the south bank of the great Machhu, are Karo, Chhussung, Pethang, Bedo, and Doyu, five districts, among which Bedo Gonpa is noted.

Close to Doyu is the lake called Lhalun-*g*yu-tsho, which is said to be the repository of many wonderful and sacred objects. In winter, when the lake becomes frozen, the ice is said to form the figure of Buddhist *maṇḍala* (in concentric rings). The Buddhist devotees say that the great and small continents of Buddhist cosmogony are there represented. In the neighbourhood of these places there lives a large tribe of Muhammadans called Jalar, who speak a kind of Persian-Tartar language. To the northward of these, following the north bank of the great Machhu, you arrive at Chya Khyung, the seat of Chhoije Tondub Rinchhen. It contains the tomb of that famous Lama, as well as the residence of Tsong khapa. The north of Machhu is occupied by the Chinese, Tibetan, Hor (Tartars) and (Lalo) Muhammadan population, where there are also a few religious establishments. To the east of this tract lie the districts called Tantig and Yangtig, in which Tantig Shelgi-Yango is a sacred place.

North of Chya khyung there is a hill called Tsong Laringmo, which crossed, you arrive in the district of Tsongkha, in which is the great monastery of Kubum (Kumbum), founded on the birthplace of the great reformer Shár Tsongkhapa Lossang Tagpa, the second Buddha of the present age. On the birthplace of Tsong-khapa there exists a white sandal-wood tree, on every leaf of which at the time of the reformer's birth there appeared a picture of the Buddha Senge naro supernaturally inscribed. Hence, from the circumstance af a "hundred thousand images of Buddha" having appeared on the leaves, the town and the great monastery is called Kumbum. Even at the present age, images are occasionally said to be seen divinely inscribed on the leaves of the Chandan tree and Súgpa trees of the grove. The enemies of the Gelugpa school say that the said images are secretly drawn with pins and needles by Gelugpa monks.

At half a day's march east of Kumbum lies the Chinese city and fort of Ssiling. Directly north of Ssiling, after a full day's march, you arrive at a hill called Tagri (Tiger hill), in which there is a fine cavern, described by Dubchhen ka*l*dan Gya-tsho to be one of the four wings of Revo-tse-nga. Proceeding further north to some distance, you arrive at the great monastery of Gahdan Tam Chhoi ling (the seat of Lama Tsanpo Nomankhan), anciently called Amdo Gomang Gonpa, which at present is well known by the name of Serkhang Gonpa. (This is the residence of our author, who is an incarnation of an eminent Tibetan Lama named Tagtse chovo, who was invited to be the abbot of the monastery.)

The monastery contains about 2,000 monks, among whom are many who know the Tshan ni*d* philosophy. Thence if you proceed northwards, after crossing a mountain pass, you arrive at Chhu Ssang (Gonpa), which contains nearly 800 monks, among whom some are versed in the Tshan ni*d* philosophy. Thence if you go south-eastward for more than half a day's march, you arrive at Gonlung (Gonpa), which contains nearly 2,000 monks. Formerly two of Je Changkya's incarnations and those of Sumpa, the author of Shvo Ser Chhoi Jung (the work called "The origin of the Yellow-hat school") and Thúkwan Lossang Chhoikyi Nima, the author of Dubtha Shelkyi Melong, both sacred personages, and several other learned men, presided over this monastery. Thence going to the south-east for about half a day's march, you come to a rock called Mar tsang, which contains the relics of the great Lama Gongpa rabsal. The historical work called Nongjung relates, that anciently Tsongkha district was a Tibetan district called in Chinese Tsongkha Ssan Sán Kaun. Tsongkha is now filled with a Chinese and Muhammadan population. Now-a-days, times having degenerated, the Tibetans and Hor people are gradually becoming followers of Kungfutsi and Lok yan (or Laotse), and the Ladak people are imbibing faith in the doctrine of Guru Nanak, so that Buddhism is on its decline. Travelling northward from Gon lung, you reach a large district called Amdo Pa*l*ri, which contains 50 subdivisions and contains several monasteries, *viz.*, Ssun Shan Taglung (Gonpa), Jog rong thur Chhen (Gonpa), Chho ten than, Tsi Chhoi ling, Kanchhen Semni (Gonpa), Dug-gu (Gonpa), Shvamar (Gonpa), Gyayag (Gonpa), Digung (Gonpa), Hor (Gonpa), Upper Nag yan and Lower Nag yang (Gonpa), Mathee (Gonpa), Dung nag Jam Yan (Gonpa), Bangur (Gonpa), Upper Gyatong (Gonpa), and Lower Gyatong (Gonpa), Chhulung (Gonpa). Gelugpa monasteries are mostly subordinate to Kumbum and Tsanpopa abbots, in consequence of which those under Je Gampo and Phagdu, have been converted into Gelugpa institutions. Close to Duggu Gonpa there is a sacred place called Katong. In Lower Pa*l*ri there is a district called Do*l*dar Hor, which contains Dethung (Gonpa), Kha thipa (Gon), Lenpah the (Gon) Ashitag, and Kamalong monasteries. Close to these lives a large tribe of China-Tibetans, within whose lands are Thang ring (Gonpa), Jalohang (Gonpa), &c., besides Padu (Gon), Chyamba bum ling, Lokyatun, Jomo khar monasteries, among which Chyambaling is celebrated for the gigantic statue of Maitreya Buddha, one hundred and eighty feet high, as well as a hundred thousand miniature images of that Buddha. A similar gigantic statue is said to exist in the Tam thung monastery of China. Lokyatun monastery contains a large image of Sambhara (the Tantrik deity who clasps a female deity in his embrace). Jomokhar contains the tomb of Chyamchhe Chhoi Je Lama and a complete set of Kahgyur and Tangyur, written in gold. On the right bank of Machhu (Hoangho) there are a few Chinese monasteries, such as Han Taglung Gonpa, &c. Formerly Chinese Hor people held the north portion of Amdo, who, joining the Tartars of Dolonor, carried on frequent depredations in China. In order to put a stop to these invasions the Emperor of China Thang Wang formed a treaty with Tibet, under the conditions of which the united troops of China and Tibet subdued the mischievous Tartars (Hors) and subjected them to the power of China. Thenceforth almost the whole of Amdo became a Tibetan province. From those Chinese Hor people many Chinese kings had sprung, such as King Hor thupa, whose rule extended over half of China.

To the north of Lake Kokonor (Tsho ngonpo), close to Pa*l* Ri, the tract is occupied by a tribe of Hor people called Sára Yugur, who are Buddhists. Within their lands there are Yugur-ta go (Gonpa), and Mag Chhu (Gonpa), and these people are said to be a sub-tribe of the great Yugur people, and their chiefs are the descendants of Pan Yan Ching called Jurje Althan Han (golden king). Within the province of Amdo lies the district of Yarmo thang, which contains the lake Thi Sár Gya*l*mo, in the bordering tracts of which there is a large tribe of Tartar people called Kokonor Mongol, who are ruled by 33 chiefs, most of whom trace their origin to the Hes'og Walgási of right Orod (or Oeluth) tribe, and some of whom are said to be the descendants of Khal kha and Thume kings. In the centre of Lake Kokonor there is a hill called Mahádeva, on the top of which are several places of sanctity, the principal of which is the Dub phug (cavern), where Padma sambhava (Urgyen Rinpochhe) is said to have meditated for the good of the world. In Kokonor province there are several monasteries, among which Tva tshang gon and Serthoggon are important.

Sítá's Window or Buddha's Shadow Cave.—By S. J. COCKBURN, ESQ., *M. A. S. Bengal.*

Sítá's window is an ancient Buddhist hermit's cave, cut into the vertical face of a precipice 50 feet high. This precipice forms the scarp of the classic hill of Prabhása, Allahabad District.

On the 27th of March 1885 I paid a visit to the hill to examine its geological structure, suspecting the proximity of Lower Vindhian strata. In the course of my rambles on the hill I arrived at the modern Jain temple of Páras'náth, which is built on a platform immediately below the scarp, and has a stone staircase leading to it from the very foot of the hill, an ascent of possibly 200 feet. Observing a rock shelter on the brow of the precipice overhanging the temple, with indistinct traces of scroll writing in the shelter, I proceeded to carefully scan the face of the cliff with my telescope, and in the course of my search, alighted on a small, and seemingly well-preserved rock-cut inscription of seven lines immediately above the door of an artificial cave, hewn in the face of the precipice. This inscription I at once saw was in the Aśoka character, my previous study of the Geology and Anthropology of the Bharhut railing having familiarized the form of the letters to my eye.

The inscription is invisible to the naked eye, when its position has not been previously ascertained with the telescope. This accounts for its having escaped the searching ken of General Cunningham and his trained assistants and staff of chapprassis who were often located for months at the adjoining village of Kusam, the ancient Kauśámbí, searching for coins and inscriptions and paying large amounts for the same. In fact General Cunningham had been more than once within 150 feet of the inscription without noticing it, and it appears to me that his Dragon's cave (see *Archæological Survey Reports,* Vol. XXI, Part I, p. 2), is merely a rock shelter, though the allusion to the windows renders it just possible that the cave seen by him is that described by me.

I was not a little elated at my good fortune, but it has cost me ten days out of my privilege leave and half a month's salary to make the eye-copy of the inscription which I now submit to the Society.

I copied one line of the inscription on the occasion of my first visit and submitted it to Dr. Hoernle who very kindly obtained me the loan of an astronomical telescope from the Principal of the Hooghly College, by means of which I have been enabled to make the present copy. I have further promised that Dr. Hoernle shall have the first right to make the first reading of the inscription.*

I revisited Prabhása on the 26th of November and devoted the 27th and 28th to copying the inscription. This I did letter by letter revising the work 8 times.

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* [See *Proceedings* for March 1887. Ed.]

Description.—The cave has one main entrance, a window about 3′ × 2′ with a stone jamb of a lighter coloured sandstone let in. From this evidently swung a wooden door. The top of the window is about 4 feet from the top edge of the precipice. To the west of the window, at a distance of 4 or 5 feet are two small windows of irregular form, evidently intended to let in light, and thus produce a shadow within the cave. The thickness of the outer wall here seems to be 7 inches. Owing to its inaccessible position I was unable to enter the cave, or make accurate measurements. The presence of numerous swarms of the *Bhaurá** or wild bee added much to the danger of the undertaking. It was possible that a swarm had possession of the cave itself, and I had not sufficient confidence in the native boatmen, or in their tackle, to have myself let over the face of the precipice by a rope. A platform might, however, easily be constructed, by which both inscription and cave could be clearly examined.

I succeeded in feeling the whole of the inscription† with my hand by lying down and having my legs held, while I hung my arm and shoulder over the precipice. I was thus enabled to darken the letters with a lead pencil and pass a wetted towel over the inscribed surface which I polished briskly with my hand, thus improving the lights and shadows.

It occurred to me that a large looking-glass, tied to poles and hung vertically a few feet in front of the inscription, should reflect the letters truly if held square. I accordingly put the idea into practice, but of course got the image reversed. I, however, found that I could get a better view of the letters with the large telescope than I could from the reflected image. The inscription might easily be photographed thus.

The accompanying sketch will give an idea of the position of the cave. The interior is of course unknown to me. It will be observed that there is a rock shelter above the cave. The floor of the rock shelter forms a ledge a yard wide. On this ledge a long flat shallow groove has been cut in the rock evidently for the reception of a metal bar. Within the groove and also without it are sundry small deep holes cut in the rock for the insertion of metal pins and staples which were probably fixed with lead. From the metal bar, I would suppose, depended a chain ladder with a small platform below, to gain access to the cave. I have attempted to reconstruct this ladder, and I would suggest that the Government took steps to replace it. The hill is one of the most remarkable objects in the Allahabad District and will some day form an object of attraction to tourists.

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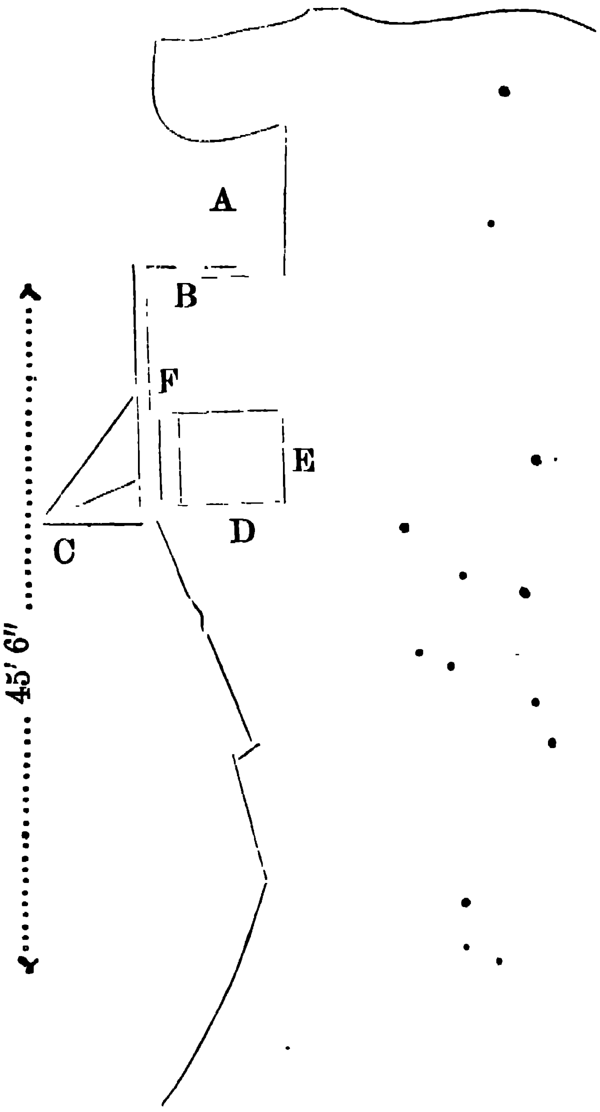
* More than once an angry swarm swung past the face of the cliff, when our voices were raised, and it would be nearly certain death, were they to attack men in this position.

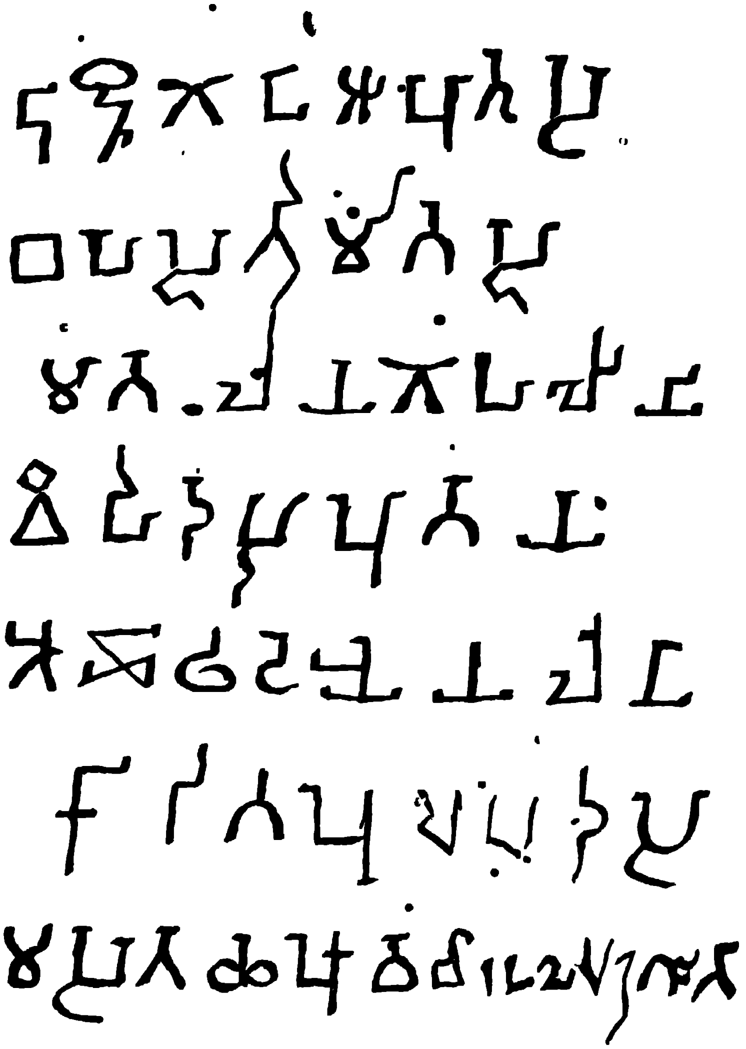
† There are also sundry letters carved on the lintel apparently of later date.



Ideal section of Sítá's window or the Buddhist Dragon cave.

A Rock shelter.
B Groove on metal bar.
C Ideal reconstruction of chain and ladder.
D Stone window frame.
E Cave (depth beyond 3 feet unknown).
F Prabhása inscription.

The inscription is carved on a sunken, and once polished surface, which is a part of the natural rock and resembles a tablet let in. The tablet measures 13½″ in length (measured) by 7 or 10 inches in width (by estimation). Each letter is on an average one inch long (measured). The position of the tablet is above the left top corner of the main entrance window of the cave, and it is to be seen in the section given. The letters are in a surprisingly perfect preservation, considering their great age, and are carried to the depth of 3·6 of an inch.



The following table will show the state of preservation of each letter and what seemed to me lost.

	B	BD	P	P	B	P	B	P							
1st	1.	2.	3.	4.	5.	6.	7.	8.							Lost one.
	P	P	P	P	P	P	P								
2nd	1.	2.	3.	4.	5.	6.	7.								Two lost.
	P	P	P	P	P	P	P	P							
3rd	1.	2.	3.	4.	5.	6.	7.	8.							None lost.
	P	P	P	P	P	P	P	P							
4th	1.	2.	3.	4.	5.	6.	7.	8.							Two lost ?
	P	P	P	P	B	P	P	P							
5th	1.	2.	3.	4.	5.	6.	7.	8.							None.
	B	B	P	D	D	D	D	P							
6th	1.	2.	3.	4.	+	+	+	8.							3 or 4 lost.
	P	P	P	P	P	P	P	P	P	P	D	D	D	P	
7th.	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	

Note—D stands for doubtful. B for broken. P for perfect.

History.—I would identify this cave with the lofty stone cavern of a venomous dragon, in which Buddha was supposed to have left his shadow, and the spot visited by Hwen Thsang in the seventh century. The permanent character of the colossal ruins of Kosambí and the hill of Prabhása should afford a valuable standard for the determination of the exact length of the Chinese Li. Hwen Thsang mentions that the cave is 8 or 9 li to the south-west of Kosambí. This bearing is, however, erroneous as the hill bears north-west from the Bhil (or stupa). General Cunningham at first supposed the cave to have been carried away by the encroachments of the Jamná (A. S. R. Vol. I, p. 311.) He subsequently seems to have found a cave (Vol. XXI, Part I, p. 2.) But it seems to me from the reference to the three standing Jain figures cut in the rock, that he alludes to a rock shelter behind the temple, and immediately below these three figures. He says, "the cave is artificial and is simply an old quarry with a pillar left in front for the roof."

Sítá's window on the contrary is one of the most perfect and typical rock-hewn caverns in existence. With a small and perfect door it has evidently considerable internal capacity and a lateral internal extension of at least 6 feet. The outer wall is without doubt the natural face of the cliff. The cave is hewn in hard grey quartzite, as is of course also the inscription. It forms a perfect cysk, with one small entrance and two apertures about 8″ square to admit of light. The irregular form of these apertures is, I consider, the best proof that this cave is that in which Buddha left his shadow, as the irregular apertures might well be constructed to throw a shadow within, having the human outline.

The cave is, as before stated, 150 feet to the north-east corner of the Jain temple of Páras'náth, and it is difficult to understand how any one could overlook it. I have clearly been able able to see the window from a distance of three miles.

The cave is now known to the people as "*Cheta Mata-kan Roseiya.*"

JOURNAL

OF THE

ASIATIC SOCIETY OF BENGAL.

Part I.—HISTORY, LITERATURE, &c.

No. II.—1887.

The Ṣafwí Dynasty of Persia. (*With four plates of unpublished coins.*)—*By* E. E. Oliver, M. I. C. E., M. R. A. S.

The present is an attempt to give an historical outline of the rise and fall of another, and much better known, Muhammadan dynasty, this time of Persia. In the case of some of those dealt with in a former paper* the material available was so scanty, it might almost be said that no reliable history exists; and little is possible beyond a gradual building up with scattered fragments and occasional discoveries, numismatic or otherwise. In the present case the material is ample, is generally reliable, and perhaps it may be added, is fairly well-known. Moreover it has been in the hands of so many experts, no one but the most eminent performer would be justified in another attempt. In most histories of Persia is to be found some notice of the Ṣafwí† dynasty, in Malcolm's splendid work the review is more fully extended, and in the volumes of Hanway the story, more especially of its decline and of the rise and fall of the famous Nádir, is graphically told at length by a contemporary, and so far as Nádir's court is concerned, an eye-witness.

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* J. A. S. Vol. LV, Part I, 1886.

† There is some difference of opinion as to the proper spelling of the name and to its meaning. Malcolm writes *Suffees* or *Sooffees*, and assumes them to belong to the sect of mystic or philosophic deists of that name. This, Vambery points out, is incorrect. He writes the word *Sefi*. Ṣafíu-d-dín was famous as a devotee, but he was not necessarily a believer in *Sufiism* or *Taṣawwuf* as it is elsewhere called by Muhammadans. The name on the inside is clear الصفوي Aṣ-Ṣafwí, and from Ismá'íl to Sulaimán they so describe themselves. [The name should rather be transliterated *aṣ-Ṣafawí*. Ed.]

Soon after Sháh Ismá'íl founded the dynasty, Europeans appeared on the scene. In the memoirs of those gallant Knights, Sir Anthony and Sir Robert Shirley, who went to Persia in the enterprising days of the great Queen Elizabeth, the former of whom took service under the first 'Abbás, and the latter of whom went as the Sháh's ambassador to the Court of James the First; in the account of Father Krusinski, the Procurator to the Jesuits who was at Iṣfahán for twenty years, from Sháh Ḥusain to Ashraf (1705 to 1725 A. D.); in the tracts of Chardin, Tavernier, de Valle, da Silva, Herbert, Thevenot, and others; and in the vernacular histories, like the *Zubdatu-t-Tawáríkh* of Quṭb bin Ismá'íl, an officer of some eminence at the Court of 'Abbás the Second, are to be found accounts more or less complete, covering a greater part of the entire dynasty. These dynastic sketches, however, as I have previously said, do not pretend to be more than the outlines of history—subject to any subsequent correction or modification, before they would even be capable of any detailed filling—and in the case of the Ṣafwís it is necessary to condense rather than to amplify.

In the subsequent pages I have followed mainly Malcolm's History of Persia,* Jonas Hanway's Travels,† and Mr. Stanley Lane Poole's tables for contemporary dynasties‡. But even in the case of a dynasty so well-known, there are still many details, historical, geographical, and certainly numismatic, required to make any history complete. More information is wanted in regard to the fortunes of the secondary houses, some of whom at times exercised considerable power; the limits within which the various princes ruled at different periods; their range of mint cities; and the identification of others no longer recognisable. No doubt the comparison of a sufficient number of their coins might enable the territorial limits of individual princes to be very approximately fixed, though how little can be done by one observer may be judged from the fact that out of several hundreds of coins sent to me for examination by various friends, I have only met with one specimen of the 'Abbás whose rule was so famous in Persia for nearly forty years, while I have seen half a dozen of 'Abbás III., a baby who occupied a nominal throne for less than four. But among the readers of the Journal are most probably others who can add largely to the list, and who if so disposed might contribute the most valuable data.

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* 2 Vols. London, 1815. [A free Persian Translation was published by Mírzá Ismá'íl Ḥairat, Professor of the Elphinstone College in Bombay, 1872. Ed.]

† 2 Vols. London, 1753.

‡ In some cases I have used Erskine and occasionally Vambery.

Possibly for such the following sketch of the dynasty may, for the purposes of comparison, prove useful.

The collapse of the Tímúrian Empire in Persia was followed by the establishment for a while of the Kurdish Turkmáns of the Qará Kuyunlí or "*Black sheep,*" and the Aq Kuyunlí or "*White sheep,*" so called from the figures borne on their respective banners. The former had been established in A'ẕarbaiján by Qará Yúsuf about 810 H. (1407 A. D.), and the two were united by Uẕan Ḥasan the ruler of Diyár Bakr about 874 H. (1469). The latter who to birth and ambition added exceptional valour and much ability, made himself master of Persia, and might have gone near to establishing an empire had not his ambition led him to quarrel with Turkey, and bring on himself a signal defeat. From his death, in 883 H., the country was a prey to constant anarchy, sons, grandsons and nephews all struggling for his territories or parts of them; and for a quarter of a century Persia was longing to welcome once more any strong ruler. At last the time came, and in the shape of Sháh Ismá'íl, the man.

ISMÁ'ÍL THE FIRST, 905—932 H., or to give him his full title, Abú-l-Muẕaffar Sháh Ismá'íl Bahádur K͟hán aṣ-Ṣafwí as-Sulṭán al-'Ádil al-Kámil al-Hádí al-Wálí, the first of the Ṣafwí dynasty, is said by some of his more enthusiastic countrymen to have traced his descent from Músá, the seventh Imám. He was more probably of Turkish origin, descended from one of the seven Turkish hordes living west of the Caspian, who assisted his rise to power.* His more immediate ancestors had been settled at Ardibíl, and were undoubtedly regarded mostly as holy men, some even as saints. The first of the family with any considerable reputation was Ṣafíu-d-dín Isḥáq, "*the pure of the faith,*" a philosophical devotee from whom the dynasty takes its name. To him succeeded Ṣadru-d-dín, "*the pre-eminent of the faith,*" who with his descendants acquired the greatest reputation for sanctity. Ismá'íl himself, if on the one side he was the representative of a family of saints, was on the other the descendant of a race of warriors, for his grandmother was the sister of Uẕan Ḥasan†, the above-mentioned chief of the Aq Kuyunlí Turkmáns, and his mother a daughter of that famous leader.

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* These tribes or Ilyats were named Ustájalú, Shámlú, Nikálú, Bahárlú, Ẕu-l-Qadr, Qájár, and Afshár. They wore a peculiar dress and a red cap, from which they were called Qazalbásh, golden-headed. [See Malcolm, vol. I, p. 502, Transl., vol. I, p. 168. Ed.]

† Ruled 871 to 883 H.

His father Ḥaidar was killed while attacking the province of Shirwán.* His eldest brother was killed in Gilán, to which district the sons of Ḥaidar had fled, and the second died, when Ismá'íl, the third son, was a child. Not much is known of him until he is 14 years old, when he appears at the head of his adherents, marching against and defeating the ruler of Shirwán in 905 H. The next year, 906 H. he defeated the Aq Kuyunlí chief Alwand,† who had attempted to crush him; and making himself master of the province of Ázarbaiján, established his residence at Tabríz. In 907 H. he marched into 'Iráq and defeated Sulṭán Murád‡, the last of the Aq Kuyunlís, near Hamadán, and in 908 H. became the acknowledged ruler of Persia. It is unnecessary to enter into the detail of the conquest of Ismá'íl. The first few years were spent in subduing the provinces of Persia that resisted his authority. Then came the quarrel between the orthodox Sunnís as represented by the Uzbak Shaibání, and the Shí'ah sect under Ismá'íl, brought on not a little by the arrogance of the former, whose hand was against every man, and whose life was a continual struggle with his neighbours. The Shí'ahs had long been repressed and cruelly persecuted, and when opportunity came for revenge in the shape of a powerful leader, reared in a strong belief in the sacred name of 'Alí, and the twelve holy Imáms, who formed a kingdom, and made the formula of Shí'ah his battle cry, they were ready enough for reprisals. Ismá'íl was not slow to take advantage of this enthusiasm, and to turn the swords of the tribes to the extension of his Empire. He attacked and took Baghdád and the surrounding territories. He then marched to Mashhad and to Merv, close to which city, at Muḥammadábád, 10 miles away on the banks of the Murgháb, he, in 916 H., entirely defeated Shaibání, who was killed in the field. Wintering at Ḥirát, he advanced to Balkh, invaded Máwaráu-n-Nahr, skirting the Paropamisan range by Maimanah and Qará Robat (917 H.), and practically annexed the whole of Khurásán and Khwárazm, the Oxus thus becoming again for a short time the boundary between Irán and Turán. Of his embassy to Bábar, the assistance given by him to that prince against 'Ubaidu-lláh,§ and of his doings in Khurásán, a detailed account is given in Erskine. On the whole he was successful, but in 920 H. he had to encounter a more powerful enemy in the form of the 'Usmánlí Sulṭán Salím|| from Constantinople, by whom, after a desperate battle, he was completely

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* West of the Caspian.

† Ruled 905 to 906 H.

‡ Ruled from 903 to 905, and again from 907 to 908 H.

§ Then the General of Köchkúnji.

|| Salím bin Báyazíd reigned 918 to 926 H.

defeated on the borders of A'ẕarbaiján,—a reverse that affected him so much that he is said to have never smiled again. Beyond the glory of defeating Ismá'íl, and the plunder of his camp, the Turks reaped little profit, and on the death of Salím, Ismá'íl crossed the Araxes river and subdued Georgia. This was the last of his conquests, for he died on Monday the 10th Rajab, 930 H. at Ardibíl, where he had gone to visit the tomb of his father.

ṬAHMÁSP THE FIRST 930 to 984 H.

When Ṭahmásp succeeded his father he was ten years old, and for long was necessarily in the hands of his ministers. He had hardly ascended the throne before he was involved in a war with 'Ubaidu-lláh the Shaibání, the most powerful of the Uzbaks, though not the actual ruler till some 10 years after. A war, or succession of wars, lasted through almost the whole of a reign exceeding half a century. The Uzbaks had obtained possession of Mashhad,* defeated the Persians near Basṭám 932 H., marched to Balkh 933 H., and advanced and laid siege to Hirát 934 H. The Persians, however, collected a large force of veteran troops, and under the new king, aged 15, beat off the Uzbak general, raised the siege of Hirát, and in 935 H.† signally defeated 'Ubaidu-lláh near Jám, with, according to Bábar's memoirs, a slaughter of the most enormous numbers. Soon after this Ṭahmásp's affairs recalled him westward again. In Baghdád a chief of the Kúrds had usurped the government, and in A'ẕarbaiján itself the Qazalbásh chiefs had fallen out. The tribes of Shámlú and Tukúlú were at open war, and Alána Tuklú had called in the aid of the Turks. While Ṭahmásp was settling matters in the west, the Uzbaks in the east were not slow to take advantage of the internal disturbance, and in 937 H. again invaded Khurásán, Astarábád, Sabzwár, Níshápúr and Mashhad falling under their sway, while Hirát was invested to the great distress of the inhabitants. The rebellious tribes quelled, Ṭahmásp sped again to the rescue, and to the relief of the Hirátís spent the winter of 938 H. there. In the spring of 939 H. he was even proposing to retaliate by invading Máwaráu-n-Nahr, when he was compelled to hark back to meet Sulaimán‡ from Constantinople who was invading his kingdom, had taken Tabríz, occupied Baghdád, and but for the severity of the season would have reduced Sulṭániyah. Ṭahmásp's active measures, however, compelled him to retire and in 940 H. to abandon his conquests. In 941 H. Ṭahmásp's brother Sám Mírzá, who had been left as governor of Hirát, rebelled, but fled on the former's approach across the Oxus, and subsequently to Qandahár. To recount these constant moves of the pieces backwards and forwards across the Khurásán chess-board is monotonous, but it must have been much more so for Khurásán and its people, the changes being rung between plunder by Uzbak and Persian, and persecution by Sunní and Shí'ah. The city of Hirát and the misfortunes of its luckless inhabitants would alone require a volume. Again in 942 H. it was taken and pillaged by 'Ubaidu-lláh, and the Shí'ahs had to suffer. In 943 H. Ṭahmásp regained it, and the Sunnís bore the brunt. Sulṭán Muḥammad Mírzá, a young prince, was made governor.

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* And Ṭús the old town close to the modern Mashhad.

† 10th Muḥarram.

‡ Sulaimán bin Salím, reigned 926—974 H.

At one time Ṭahmásp extended his power as far as Qandahár, at another 955 H. the Turks were masters as far as Iṣfahán, and for some years war with the latter continued. Ultimately the anarchy which prevailed in the Turkish empire ensured the peace of Persia; and the death of 'Ubaidu-lláh rendered the Uzbaks less troublesome. In 960 H. Ṭahmásp subdued Georgia, and took some unimportant cities in Asia Minor, but shortly after gave over charge of his armies to his generals and settled down at Qazwín, which he made his capital. The reign of Ṭahmásp, as Malcolm remarks, owes much of its celebrity to the truly royal and hospitable reception he gave to the Emperor Humáyún, a full account of which may be read in Erskine. This was in 950—51 H. Ṭahmásp died in 984 H. at the age of 64, after a reign of 53 years.

ISMÁ'ÍL THE SECOND 984—985 H.

Ṭahmásp left a large family. Ḥaidar, the favourite of five sons, who had been kept at court while his brothers were employed elsewhere, seized the palace and proclaimed himself king, but he neglected two very important matters—to seize the treasuries and secure the support of the ladies. The neglect of the latter promptly brought* him into the toils of Ṭahmásp's favourite Sulṭánah, Parí-Khán Khánam, the sister of Shamkhál, chief of the Chirkas tribe, by whose intrigues he was massacred, before his friends could assemble, and his brother Ismá'íl, at the time imprisoned in the Fort of Kahki, was immediately proclaimed king, 984 H.

Coming straight from a prison to a throne Isma'íl's short reign was a brief record of debauchery and crime. His first act was to direct the massacre of all the royal princes at Qazwín, save one 'Alí Mírzá, whose eyes he put out. Ṭahmásp's eldest son Muḥammad had, owing to a natural weakness of his eyes, been supposed incapacitated for the succession. As above noticed, he had been made governor of K͟hurásán, and subsequently had gone with his eldest son Ḥamzah to Shíráz, leaving an infant son 'Abbás, as nominal governor of K͟hurásán under a regent. Ismá'íl now sent off orders to Hirát and Shíráz for the immediate massacre of Muḥammad and all his family, but hardly had the mandate for the murders been dispatched, when a breathless messenger sped with the news that Ismá'íl himself was dead. A midnight debauch, with a seller of sweetmeats for a boon companion, an unusual quantity of liquor, with too much opium, and the king was found dead in a room at the confectioner's (985 H.).

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* [Malcolm, Vol. I, p. 514, spells the name *Pari-Khan Khânum*, but the Persian Translation makes it *Pari-Ján Khánam*, which is probably the correct form. Malcolm, ibid., spells the name of the fort *Kâhke* (Transl., p. 172, کهک *kahk*), and says, it is believed to be the modern *Sheshâh*, (Transl. شیشه *shíshah*). Ed.]

MUḤAMMAD 985—994 H.

On Ismá'íl's death Muḥammad, often called K͟hudábanda "*the slave of God*" was instantly proclaimed king (*bádsháh*). His first act was to put to death Parí K͟hán K͟hánam,* and the Chirkas chief, and his next, to entrust the charge of the empire to a somewhat able Wazír, Mírzá Sulaimán, a man whom he subsequently sacrificed. Muḥammad's whole character was as weak as his eyesight; he was dissipated and a coward, and under his feeble rule the empire of Ṭahmásp began rapidly to fall to pieces. The year following his ascension, 986 H., saw Persia invaded by the Turks, the Uzbaks, and the Qipchaq Tátárs. Affairs in K͟hurásán fell into the wildest anarchy, and in 990 H. the nobles there advanced to Níshápúr, and proclaimed his son 'Abbás the king of Persia. Muḥammad's first campaign was an ineffectual effort to take Turbat. His next the siege of Hirát defended by 'Abbás 991 H., where, notwithstanding he handed over the Wazír Sulaimán to the vengeance of the Qazalbásh chief, he entirely failed to establish his authority. In 991 H. his cruelty had involved him with the Turkmán tribes of Tukúlú, and in 993 H. these internal troubles encouraged the Constantinople Sulṭán|| to invade Persia, whose general 'Us̱mán Pasha succeeded in taking Tabríz, Muḥammad's own tribal chiefs refusing him aid. Ḥámzah Mírzá, his eldest son, to some extent extricated his weak father from his difficulties, compelled the rebel chiefs to submit, and by reprisals forced the Turks, whose general 'Us̱mán was dead, to consent to peace. But in 994 H. Ḥamzah was unfortunately stabbed by a barber, and Muḥammad's power practically terminated from that date.†

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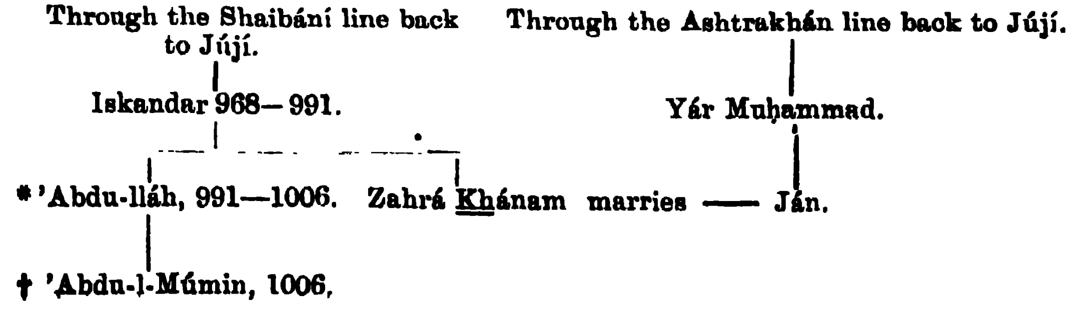
* [See note on p. 42. Ed.]

† Murád III bin Salím 982 to 1003 H.

Khurásán was practically independent all through his reign. Two powerful Qazalbásh chiefs, 'Alí Qulí and Murshid Qulí Khán nominally protected 'Abbás, but were really rival powers. Ultimately they fell out, fought, and Murshid was victorious. On Ḥamzah's death he marched with 'Abbás to Qazwín which the two took possession of without opposition; Muḥammad simply disappearing from the scene, deserted by every one. "His inefficiency," says Malcolm, "was so marked, he was probably permitted to die a natural death." At any rate he drops out of history.

'Abbás the First 994—1037 H.

'Abbás was now strong enough to get rid of Murshid Qulí Khán, which he did in the usual way, by slaying him, and taking full power into his own hands. Almost as soon as he had left Hirát, the Uzbaks beseiged it, and though in 995 H. he marched to its relief, he had to return to his capital without effecting his purpose; for he had to hurry back to Georgia where the 'Uṣmáníís threatened him. All through the history of the time difficulties with the Turks in the west were invariably echoed by the Uzbaks in the east, and *vice versâ.* The marching and countermarching must have occupied most of the ruler's time. 'Abdu-lláh Khán,* the Shaibání, no sooner heard of Western difficulties, than he moved on the sacred city of Mashhad, entrusting the command of his army to 'Abdu-l-Múmin Khán,† then governor of Balkh. 'Abdu-l-Múmin was a thorough savage, and when in 996 H. the holy city of the Shí'ahs fell into his hands, it was literally given over to the furies. The Uzbaks spared neither age nor sex. The sacred shrine of Imám Raẓá, the richest and most celebrated in Persia, was deluged with the blood of philosophers and peasants, children and old men. Massive gold and silver candelabra, jewelled armour, priceless copies of the Qurán, and precious relics of every description, the accumulated offerings of pious pilgrims for three centuries, were remorselessly pillaged. Even the ashes of the dead were not spared, Ṭahmásp's



being torn from their grave and scattered to the winds by infuriate Sunnís.[*] Meanwhile 'Abbás was lying ill at Ṭihrán, and for some time after his recovery was too much occupied to take any vigorous action in Khurásán, a large part of which remained at the mercy of 'Abdu-lláh (Shaibání). He had in 997 H. to put down a rebellion in Fárs, where one Ya'qúb had shut himself up in the fort of Isṭakhr, from whence he returned by Yazd to Qazwín, in 998 H., to watch the Turks on the Tiflís frontier, and in 999 H. to reduce the province of Gílán; and it was not until about 1004 H. that he was able to commence active operations against the Uzbaks. He first took Sabzwár and Mashhad, and later Hirát, near which place he at last forced the Uzbaks, under Ṭáhir Khán,[†] to fight, and defeated them with great slaughter, the 6th of Muḥarram, 1006 H., Prince Dín Muḥammad Khán[‡] and great numbers of their leaders being among the slain,—a victory that gave Khurásán a long rest.

In Transoxania the dynasty of Ashtrakhán had just, 1007 H., succeeded the Shaibánís, the first of whom, Báqí Muḥammad,[§] united both houses. Dín Muḥammad, the elder brother, had been slain by the Persians, but the younger, Wálí,[||] established himself at Balkh, now reputed little better than a collection of mud huts, but then spoken of as "the Mother of cities." About 1011 H. the Persians would seem to have suffered a severe defeat at the hands of this Báqí Muḥammad, a defeat from which, Vambery says, 'Abbás escaped with difficulty. The principal object of 'Abbás in the Transoxus direction would, however, seem not so much to have been conquest, as the establishment of a good understanding with the rulers of Bukhárá. We find him afterwards assisting Wálí Muḥammad with a large Persian army against his nephew Imám Qulí,[¶] and though unsuccessful, he eventually established peaceful relations on the Oxus, which lasted the whole of his reign. The tomb of Imám 'Alí Raẓá became more than ever an object of devotion to the pious, the priceless diamond 'Abdu-l-Múmin had looted was restored, and 'Abbás, by way of showing his own piety, walked on one occasion, accompanied by all his staff, from Iṣfahán to Mashhad.

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[*] See the most interesting detailed account in Vambery's Bukhárá.

[†] A nephew of 'Abdu-lláh. This fight took place just before the dynasty closed with Pír Muḥammad Khán II, in 1007 H.

'Abdu-lláh, 991—1006. Zahrá Khánam marries —— Ján.

[‡] Dín Muḥmd. [§] I. Báqí Muḥmd., 1007. [||] II. Wálí Muḥmd., 1014.

[¶] III. Imám Qulí, 1017. IV. Nádir Muḥammad, 1050.

While 'Abbás was extending his territories in the direction of, if not on occasion actually as far as, Balkh, his generals, operating along the Persian Gulf, had conquered the island of Baḥrain and brought under subjection the Province of Lár from Shíráz to Gámbrún, or Bandar-'Abbás, as it was afterwards called. The year 1012 H. found him strong enough to commence a long contemplated attack on the Turks,* in order to recover the lost provinces of Persia. He began by capturing Naháwand,† following this up by the capture of Tabríz in 1013 H., and I'rwán in 1014 H., in which year he fought a great battle, 60,000 Persians to 100,000 Turks, according to Anthoine de Corvea, and won a most complete victory. After this the Turks never again rallied during 'Abbás's lifetime, and were successfully driven from A'zarbaiján, Georgia, Kúrdistán, Baghdád, Manṣil and Diyárbakr, including Najaf, Karbalá, and other places sacred by association with the remains of the Khalífah 'Alí. Of the recovery of Hurmuz from the Portuguese, his alliance with the Emperor of Dehlí, his relations with European powers, as told by the Shirleys, and his general character, particulars are all to be found at length in Malcolm. He is almost invariably esteemed by Persians as one of their very greatest kings, and to his long and successful reign are popularly ascribed nearly all the fine works that exist in that country. He enlarged its boundaries in every direction, and maintained all his acquisitions intact till he died. "He gave," says Hanway, "a martial spirit to the people, polished their manners, and brought the governors of the Provinces, who were before in a great measure independent, into subjection." But his reign was marked by the most unhappy suspicion of his own children, and the most barbarous cruelties to them. He caused the eyes of the two youngest to be put out, and the eldest to be murdered, a crime for which he repented in bitter tears, made the executioner of the eldest bring in the head of his own son by way of punishment, and finished by inviting all the Lords who had excited his jealousy against his son to a feast, where he mixed poison with their wine, and watched them expire in his presence. Leaving out of the questions this treatment of his own family, there is no doubt he was on occasions cruel to a degree, not merely to enemies, but to his rebellious subjects. Allowances must at the same time be made for the unsettled state of the kingdom and the customs of the country, which even to this day make the sovereign the director of all executions. Probably rebellion was rife, and sedition required stern examples. While affecting great piety and making pilgrimages, he dearly loved the bowl and made much love to the ladies. He hated the Turks, but was tolerant to

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* Muḥammad III bin Murád, 1003 to 1012.

† 40 miles of south of Hamadán.

Christians. In his own family he seemed to have fits of absolute madness, but he was substantially a good ruler to his country. He made several wars, but he finally established a tranquillity unknown for centuries, and as Chardin observes, "When this great Prince ceased to live Persia ceased to prosper."

He died on the 23rd Jamádá-l-úlá, 1037 H. in his favourite palace at Faraḥábád in Mázandarán at the age of '70. He had been nominally ruler almost from his youth, and was sovereign of all Persia for 43 years.

ṢAFÍ.

To the great 'Abbás succeeded a series of weak and debauched monarchs, who may be briefly dismissed. Hitherto the Ṣafwís had mainly been brought up as soldiers; henceforward as a rule they were taken from the seclusion of the harem. Reared among women and eunuchs, they proved effeminate and incompetent, with no experience of government or capacity for war; and, as was to be expected, the power of Persia rapidly declined in their hands. For some years the nation lived on its reputation, but every season saw its decline, and almost every reign witnessed provinces lost. Sám Mírzá, the son of the murdered Ṣafí, succeeded his grandfather, as Sháh Ṣafí. Brought straight out of the *ḥaram* at 17, "where," says Hanway, "he had no conversation except with eunuchs, was taught nothing save to read and write, and allowed no diversion other than shooting with a bow or riding in the garden on an ass," his thirteen years of reign were a succession of barbarous cruelties. He began by ordering the eyes of his brother to be cut out, his blind uncles to be cast from a rock, the leading ministers to be either blinded or executed, and a batch of ladies of the *ḥaram* to be buried alive. Some authors include among these his mother, and Tavernier says, "when in his cups he stabbed his favourite Queen." Finally he ordered an iron to be run across the eyes of his own son, 'Abbás, an order which the eunuch humanely carried out with a cold instead of a hot one. Imám Qulí, the general of his grandfather, the conqueror of Lár and of Hurmuz, was among his subsequent victims. Once more the Uzbaks invaded Khurásán, and Qandahár was lost. The Turks under Murád,* returned to Áẕarbaiján, and recaptured Baghdád, 1044 H. But even a bad king cannot at once ruin a disciplined army, and less mischief was done than might have been expected. Ṣafí's object appeared to be to destroy his aristocracy, by whom he was even more despised than dreaded. Not a little of his cruelty was due to cowardice. 'Abandoned to sensuality, he trusted his affairs to ministers, whom he was equally ready to destroy the moment his suspicions were aroused. Yet in spite of all this, so great had been the power of his predecessor, that he reigned, with the above noted exceptions, almost in peace. He died 12 Ṣafar 1051 H. at Káshán, and was buried at Qum.

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* Murád IV bin Aḥmad, 1032 to 1049 H.

'ABBÁS THE SECOND 1052—1077 H.

The second 'Abbás was not ten years old when he succeeded his father,* and for some years was of course entirely in the hands of ministers. These were reputed as exceedingly religious and austere, and desirous of reforming the Court and the nation. Wine was prohibited, drunkards were removed from office, and female dancers proclaimed. At the Capital, says the Zubdatu-t-Tawáríkh, men feared to listen to anything but prayers. The result of this abolition of cakes and ale was to ultimately drive the boy king to the other extreme. As soon as he was old enough to get free of the restraint, he indulged in drunken orgies with any one who would drink with him, and his constant low amours resulted in disease which killed him æt 34. Phillip drunk was cruel, capricious, and unjust, but Phillip sober seems to have ruled fairly well. If severe to the rich, he was lenient to the poor. The lives and property of the people were safe. The religious enjoyed a liberal measure of tolerance. The army was successful, and the country at large knew him for a just and even a generous king. Qandahár he recovered in person before he was 16. (1058 H.) Peace was established with Turkey that lasted during his reign. The Uzbak chief Nádir Muḥammad,† who had been driven to fly from Balkh, he entertained sumptuously for over two years (1052—1055 H.), and successfully assisted with troops against the forces of Sháh Jahán, the Emperor of Dehlí; and again when Nádir had in 1060 H. to flee from his son,‡ 'Abdu-l-'Azíz, he found him first an asylum, and subsequently a grave. Finally he died, a somewhat miserable death, in his palace at a village called Khusrúábád near Damaghán in 1077 H.

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* Born 18th Jamádu-l-ákhir 1043. Ascended the throne 20th Ṣafar 1052 H.

† IV, Nádir Md. 1050—1057.

‡ V, 'Abdu-l-'Azíz 1057—1091.
VI, Subḥán Qulí 1091—1114.
VII, 'Ubaidu-lláh 1114—1117.
VIII 'Abdu-l-Faiẓ 1117—1160.

SULAIMÁN THE FIRST 1077—1106 H.

The eldest son of 'Abbás II. was another Ṣafí, at his father's death about twenty years of age. Some attempt was made to set him aside in favour of a younger brother, but the proposal was defeated by a faithful eunuch, and he ascended the throne in 1077 H. under the title of Sulaimán Sháh. Physically exceptionally strong, he seems to have been morally exceptionally weak. Unwarlike to cowardice, dissolute, dividing his time between the pleasures of the table and the pleasures of the harem, where, at one period, he remained immersed several years at a stretch, leaving his country to govern itself,—and his country seems to have done as well without as with him. The favourite of the time was almost absolute, though he occasionally risked having perforce to get drunk with his master, who objected to too virtuous a minister. His court was as splendid as any of his predecessors; strangers were encouraged and protected, and many Europeans resorted there. We find the East India Company's Agent sending for chests of sack, claret and Rhenish as the surest way to secure the favour of the king. The Uzbaks, however, renewed their annual invasion of Khurásán. The Qipchaq Tátárs harried the shores of the Caspian; and the Dutch seized the island of Kishmah in the Persian Gulf. All this Sulaimán is described as bearing most meekly, and to have been ever ready to turn the other cheek to the smiter.

There is but little else to tell. Like his predecessors, he extended his hospitality to the house of Ashtrakhán, and when, in 1091 H., 'Abdu-l-'Azíz, the Daniel Lambert of his time, with 300 pilgrims passed through to Mekka, he was treated with regal honours. Sulaimán died, worn out with his excesses in 1106 H. in the 49th years of his age and the 29th of his reign.

SHÁH ḤUSAIN, 1106—1135 H.

With the accession of Sháh Ḥusain the progress of Persia downhill became still more rapid. Equally as weak and indolent as his father, his weakness was united to bigotry that proved worse for his country than the vices of his predecessors. Chosen by corrupt eunuchs and fanatical mullás on account of this very character, they were able to misgovern Persia in his name. None but creatures of these men were appointed to high stations, displacing the old nobles. Religious persecution became the rule. "Merit," says Ḥanway, "became an empty sound, all offices and dignities were given to those who paid the highest price, money decided everything, * * The troops discouraged by ill discipline and worse pay, served with reluctance. Robbers infested the highway, and interrupted commerce. * * Justice was sold in the very capital of the Empire."* The colleges became a sanctuary for murderers. What spirit remained in the nation became rapidly broken. For some twenty years of his reign matters went on getting steadily worse, but showing little sign of the coming storm that was to wreck Persia and break up the Ṣafwí dynasty for good.

It is unnecessary to enter here upon the history of those Afghán tribes whose country is the mountainous tract between Khurásán and the Indus. Never a homogenous nation, and never able to form anything worthy the name of a national government, they were then, as now, ruled by chiefs the most determined opponents of all foreign rule, and to a man, born with the strong desire for a wild personal freedom, which qualities, united to great bravery and physical power, made them turbulent and dangerous subjects, and, on occasion, formidable foes. Nor is it needful to go over details of the story that made them, temporarily at least, masters of Persia,—a story that with all the elements of romance, has been often, and so effectively, told by Hanway, Malcolm, Malleson, and others. The tribes had for long been growing more powerful, and were at the time driven to extreme discontent. The most prominent place among them had come to be taken by the Ghiljís or Ghilzais, who, with the Abdálís of Hirát, became subjects of Persia when 'Abbás I. took Qandahár. The Ghiljí discontent had almost reached the stage of revolt.

The ablest general of Persia at the time was a Georgian, named Gurgín Khán. Born a Christian, he had turned Muhammadan, and became famous for his skill and his severity. He was therefore sent, with 20,000 men, as governor of Qandahár. Foremost among the Ghiljís was a chief named Mír Wís,* a man of superior intelligence, good manners, eminently diplomatic, rich, generous and influential. On this man Gurgín Khán promptly fixed a quarrel, and sent him a prisoner to Persia—probably the most stupid thing he could have done. The story of Mír Wís will repay reading at length in Hanway or Malleson. In place of prisoner, he became the confidential adviser of Sháh Ḥusain, returned to Qandahár viâ Mekka with full powers from the Persian King and with the additional religious influence attaching to a Hájí, raised a revolt, slew Gurgín Khán and all belonging to him in the true Afghán fashion, declared himself independent, and became the first king of Qandahár. There he reigned eight years, defeating three Persian armies sent against him, in 1122, 1125 and 1126 H. and died in 1127 H. He left two sons. Maḥmúd, the elder, being considered too young, the government devolved upon Mír 'Abdu-lláh, the brother of Mír Wís, a man so timid that he could never enjoy Afghán confidence, and when in 1130 H. Maḥmúd slew him with his own hand, the latter was at once hailed as king. The failure of the Persians to hold their own in other directions encouraged Maḥmúd to attack them, and in 1133 H. he invaded Persia by way of Kirmán, which immediately submitted. He was, however, shortly after met and driven back by the Persian general, Lutf 'Alí Khán. The following year this very general was dismissed, a signal for his army to disperse, while another brother Fatḥ 'Alí Khán the prime minister, was deposed and blinded, by which orders of the wretched court of Iṣfahán the Sháh lost the best of his advisers. This brings us down to 1134 H.

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* [Spelled *Meer Vais* by Malcolm and میرویس in the Persian translation, Vol. I, p. 201. Ed.

Serious troubles in other quarters have been referred to. In 1132 H. the Kúrds had advanced to Hamadán, and committed robberies under the very walls of Iṣfahán. The Uzbaks had carried terror all over the northern part of Khurásán. In Daghistán, on the western side of the Caspian, the Lesgís were masters of Ganja and Shamákhí, and in 1134 H. were at the gates of Irwán. Hirát had revolted, and the Abdálí Afghans, under Asadu-lláh Khán, entirely defeated 30,000 Persians under Ṣafí Qulí Khán, and threatened Mashhad. The Arabs of Muscat were recovering the islands in the Persian Gulf. Even the elements added to the general misfortunes: Tabríz was destroyed by an earthquake, in which 80,000 persons are said to have perished, and astrologers held that an extraordinary dimness of the atmosphere portended the destruction of Iṣfahán. The prophecy was not long unfulfilled. Maḥmúd renewed his attempt with a larger and better appointed army, overran the whole of Southern Persia, taking city after city, by Sístán, Kirmán, Yazd, and finally defeated Sháh Ḥusain's army at Gulnábád, 3 miles from Iṣfahán. The victory placed the capital at his mercy, suburb after suburb fell, Faraḥábád, Julfá, 'Abbásábád, and Ben-Iṣfahán. Finally starved to the direst stage Ḥusain surrendered his capital, and marching through the streets in deep mourning, with his own hands placed his royal plume in the turban of Maḥmúd, and in a somewhat dignified speech, wished him prosperity. The Ghiljí king had become the Sháh of Persia, and the Ṣafwí dynasty was practically at an end, 1135 H. (23rd October, 1722 A. D.)

THE AFGHANS IN PERSIA.

Maḥmúd 1135—1137 H.

The Afghán rule—it could hardly be called government—in Persia was short; less than eight years, but they were eventful years, and for the country ruinous. Maḥmúd, who in some respects just missed being a great man, showed at the commencement of his reign a certain amount of statesmanship. He endeavoured at once to relieve the inhabitants of Iṣfahán from famine, to establish confidence by continuing the best of the Persian officials in office, to induce settlers to come, to encourage foreigners, and to tolerate religion. Personally ugly almost to deformity, he had great courage, strength, and energy,—qualities it may be said common to many savages. Anything like an attempt at civilized government, however, did not last long. Prosperity spoiled him, his rapid successes developed ferocity, and finally, apprehension for his safety, combined with great physical suffering, developed all his savage instincts, and converted him into an insane and cruel monster.

Sháh Ḥusain had recognised as his heir his son Ṭahmásp, who during the reign of Iṣfahán had fled to Qazwín, where he collected a force took the title of Sháh Ṭahmásp II. and all through the reign of Maḥmúd and Ashraf made weak and ineffectual efforts to get back the throne. Another figure here appears on the scene—Peter the Great, the Russian Czar, who now took advantage of the confusion in Persia, "to extend his commerce," a euphemism for extending his dominions, on the western shores of the Caspian. Adopting the same formula which his successors have since followed with such good effect, he called on Maḥmúd to redress certain wrongs his subjects were alleged to have entertained at the hands of border tribes, and on Maḥmúd pleading his inability, issued a proclamation declaring "he had no ambitious designs of extending his territories," arrived on the coast of Dag͟histán, and as a commencement annexed Darband, and part of the province of Shirwán 1135 H. (1722 A. D.) The Turks followed suit and advanced to Hamadán with an army, and all through the Afg͟hán occupation it may be said the Courts of Constantinople and St. Petersburg cherished designs against Persia, which it was mainly jealousy of one another prevented their executing. The Russians seized Báku, and part at least of Gilán, while their minister concluded a treaty with the exile Ṭahmásp II., in 1135 H.,[*] which was to establish him on the throne in return for the cession of the provinces of Dag͟histán, Shirwán, Gilán, Mázandarán and Astarábád, that is, a large part of Persia with the entire territory adjoining the Caspian. Kúrdistán had acknowledged the Turks, who were practical masters of Írwán, K͟huwí,[†] Nak͟hjiwán, Marág͟hah, almost the whole of Armenia, and a large part of Áẕarbaiján. After a most obstinate battle, lasting four days, Tabríz had surrendered 1137 H.,[‡] and the city of Ganjah the same year. In 1138 H. a partition treaty was actually concluded between the Russian and the Turk, but this and the subsequent events belong properly to the reign of Ashraf.

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[*] 23rd September, 1723 A.D. [†] Near Tabríz. [Spelled *Khoos* by Malcolm, and خویی in the Persian Translation, vol. II, p. 9. Ed.] [‡] 3rd August, 1725 A. D.

To foreign invasions were added still greater domestic difficulties. The inhabitants of Qazwín, Khwánsár, and other cities revolted 1136 H. Qazwín, however, with Káshán, and Qum surrended to Maḥmúd's General, though he was less successful in Sijistán. From several quarters at once the Afgháns were driven in on Iṣfahán, and Maḥmúd became apprehensive even of the capital. Once alarmed, he adopted a characteristic Afghán policy. He invited to a feast about 300 of the principal Persian Ministers and Lords, and massacred every one. To prevent the sons ever revenging their fathers, the next day he slew the male children of the nobles to the extent of 200. He dined 3000 of Sháh Ḥusain's old guards in the palace square, and not one was permitted to leave that dinner alive. He depopulated the city by an order to put to death every pensioner who had served the former government, and gave over Iṣfahán to general murder and plunder. To re-people the unfortunate capital he invited Kúrdish tribes, and he raised new levies from Qandahár. With these he captured Gulpáigán, Khwánsár, Káshán, and certain cities of 'Iráq, and in Fárs his general Zabardast Khán took Shíráz by assult 1137 H.* Then he fell into a bad way again. His cousin Ashraf, whose father he had stabbed, deserted him, and his general Amánu-lláh was discontented. He lost confidence in his army, and his mind became altogether unhinged. He performed "*Tapassa,*" a most severe penance, including fourteen days fast in a dark vault, and while in this state, hearing that Ṣafí Mírzá, a son of Sháh Ḥusain had fled, he issued an order for the massacre of all the reigning family.

Thirty-nine princes were said to have then perished, the two youngest being accidentally saved by being held in Sháh Ḥusain's own arms. Hanway says the number was nearly 100, for among all the voluptuaries who ever sat on the Persian throne, probably none were more extravagant than Sháh Ḥusain. Commissioners were constantly engaged in recruiting for his harem. Hanway tells a great story of the "year of virgins," and insists that as many as thirty cradles in a single month were required in the seraglio. To kill off the children of a king, with the exception of one or two reserved for succession, was almost the rule, so that in the case of so eminent a sire as Sháh Ḥusain, a wholesale massacre is easily intelligible.

The close of Maḥmúd's career brought with it a terrible Nemesis; in addition to disease, he finally developed outrageous insanity, and died, some say finally smothered, a raging maniac, under excruciating tortures of mind and body.

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* 13th April, 1724.

ASHRAF, 1137—1142 H.

Ashraf who succeeded his cousin (22nd April 1725), joined, according to Hanway "the valour of Maḥmúd to the moderation and cunning of Mír Wís." His first measures, however, were hardly less cruel than those of the former, and sadly wanting in the diplomacy of the latter. His first order was for Maḥmúd's head, and his next to put to death the nobles and commanders who had served, and in many cases well served, his cousin. With Afg͟hán cunning he invited Ṭahmásp II. to come to Iṣfahán as a friend, but that prince had sufficient acuteness to wait till he could come with an army, and Ashraf had for the time being to be content with putting to death Ṭahmásp's correspondents.

The Turks had now got far ahead of the Russians in their partition of Persia, and in 1138 H. (1726 A. D.), marched a large army to the capital. Ashraf, however, between diplomacy and generalship, completely outmanœuvred and defeated them, with the loss of 12,000 men, the Turks having to retire to Karmánsháh, and finally to Bag͟hdád. Eventually, as his object was to make peace with so powerful an enemy as soon as possible, he concluded a treaty, ceding Kúrdistán, K͟húzistán, part of Áẕarbaiján, Sulṭániyah, Ṭihrán, and certain cities of 'Iráq, in return for which the Turks were to recognize him as sovereign. This gave him time to turn his attention to other dangers. A brother of Maḥmúd's held Qandahár. Málik Maḥmúd, the governor of Sijistán, proclaimed himself independent. The Abdálí Afg͟háns were still in possession of Hirát. But by comparison these were minor evils; before long he had to face a still more formidable enemy,—a soldier of fortune, at first a mere obscure peasant, a Turkmán by birth, a robber by profession, but who was destined to make himself a world wide reputation as a conqueror. This was Nádir Qulí, then in the service of Ṭahmásp. The latter had fixed his court at Faraḥábád in Mázandarán, where he was supported by the Qájárs of Astarábád. Nádir, already well known as an irregular leader of fame, joined him in 1139 H. (1727 A. D.) with 5000 men. So did Fatḥ 'Alí K͟hán Qájár with 3000. This determined Ṭahmásp to act on the defensive, and he appointed Nádir to the sole command. Nádir at once disposed of a possible rival in Fatḥ 'Alí K͟hán, reduced Mashhad and Hirát, and the first season compelled K͟hurásán to acknowledge Ṭahmásp.

Ashraf had just succeeded in taking Yazd, and as soon as Nádir, now christened Ṭahmásp Qulí K͟hán, took the field, advanced boldly to meet him. The armies met at Damag͟hán 1141 H. (1729), and the Afg͟háns were defeated. The G͟hiljí, however, was by no means inclined to give up the game, and prepared to defend the capital. His entrenchments were strong, and were well defended, but again the Afghâns were driven back, with the loss of 4000 men. Ashraf had now to abandon Iṣfahán. He revenged himself by slaying the old ex-King Sháh Ḥusain, and fell back on Shíráz 1141 H. (1729). Here Nádir fast followed him, and again, near the ancient Persepolis, the Afghâns were beaten,* 1142 H., and driven in confusion into Shíráz. Ashraf escaped by way of Sijistán, where he was finally murdered by a Bilúch chief, who sent his head to Ṭahmásp. Thus ended the Ghiljí rule, a period of savage terror, that had brought grievous ruin on Persia, and had probably cost a million of lives, and the desolation of many of the finest provinces. Probably few of the Afghâns, who were a small army of foreigners in the midst of enemies, ever got back. Many were killed, others sold into slavery. The fate of a few is described at length in Malcolm.

ṬAHMÁSP THE SECOND. Nominally Restored. 1142—1145 H.

The destruction of the Afghâns had not, however, the effect of restoring the line of the Ṣafwís. Although Ṭahmásp appears as a nominal king, it was merely as a puppet of Nádir's. Always jealous, Ṭahmásp once ventured to proclaim the general for disobedience. This dated the annihilation of any little power he ever enjoyed. Nádir at once marched to Court, and dictated what terms he chose. Ṭahmásp was treated respectfully, but given to understand he was not to do more than play at being king. In 1143 H. (1730) Khurásán, Mázandarán, Sijistán and Kirmán, four of the finest provinces, were formally made over to Nádir as a reward for delivering his country, and he was requested to assume the title of Sulṭán. He accepted all but the title, though he ordered coin to be struck in his own name.

As soon as his troops had rested from thrashing the Afghâns, Nádir turned his attention to the Turks. He encountered and defeated the Turkish force under two Pashas at Hamadán, made himself master of the cities of Tabríz, Ardibíl, and was preparing to besiege Írwán, the Armenian capital, when he had to return to put down an Afghân rebellion in Khurásán 1144 H. (1731). This he summarily did, reduced the fortresses of Faráh and Hirát, celebrating his victory in a splendid feast, for which the heads of 300 Afghâns furnished the decorations.

While Nádir was engaged in this practical buisness, the weak Ṭahmásp was persuaded into trying a little fighting against the Turks on his own account. He had just sent to Maḥmúd I. who had succeeded Aḥmad III.† in Constantinople a "sweet-scented letter of congratulation," and then by way of commentary marched to besiege Írwán, engaged the Turkish army, by which he was thoroughly beaten, and marched home again. Nádir now came to the natural conclusion that the time had come to put a stop to Ṭahmásp's playing at king. So he proceeded to Iṣfahán, deposed him in 1145 H.,* and deputed him to Khurásán, with "a sufficient number of ladies, and every other comfort deemed necessary to pleasurable existence."

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* 15th July, 1730 A. D.

† Maḥmúd I, bin Muṣṭafá 1143—1167 H.

He also wrote a letter to the Turks, short, and much to the point, though perhaps not so "sweet-scented." "Restore the Princes of Persia or prepare for war." At the same time he concluded a peace with Russia, stipulating that that power should abandon all the conquests it had made on the shores of the Caspian, and, with a vigour that might well serve as an example to more modern treaty-makers, he "dispatched officers to see that there was no delay in executing their clause of the treaty."

'Abbás the Third, a nominal King, 1145—1149 H.

Still Nádir did not think the time ripe for seizing the actual crown of Persia, and therefore put up a second puppet, not so likely to play at war, in the shape of Ṭahmásp's baby, 8 months old, under the title of 'Abbás III.; in whose name money was coined, and who sat upon the throne for some three years, when the baby conveniently died of some approved infantile complaint. Meanwhile Nádir marched a large army to Baghdád, and again attacked the Turks, under Ṭúpál 'Uṣmán. The action was one of the most bloody ever fought between Turks and Persians. Nádir had two horses shot under him, and both sides suffered severely, but the fight resulted in a victory for the former, 1146 H.† A defeat like this only served to bring out the genius of Nádir. Within three months he had rallied and strengthened his army, to such an extent that he was able to re-engage and defeat the Turks, who were utterly routed. The hero Ṭúpál 'Uṣmán—a long account of whom is to be found in Hanway—was killed, and Nádir invested Baghdád. The Pasha there concluded a treaty which the Court of Constantinople refused to ratify, and a general named 'Abdu-lláh, with a still larger army, put at 110,000 men, marched against the Persians, Nádir meanwhile occupying Armenia and Georgia. The Turkish general, confident in his superior numbers, left his entrenchments, and engaged the Persians. Led by Nádir in person, the latter proved irresistible. 'Abdu-lláh Kaupraulí‡ was killed and seeing his head fixed on a lance, the Turks fled. Tiflís, Ganja, Kárs, and Irwán, all submitted to Nádir, and the Ottoman Court was glad to conclude a peace on the lines whilom proposed by the Bag͟hdád Pasha.

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* 26th August, 1732.

† 17th July, 1733 A. D.

‡ The Pachá of Cairo, Hanway calls him.

NÁDIR SHÁH. 1149—1160 H.

On the eve of this victory was brought news of the death of the baby king, and now Nádir thought the time had come for the actual assumption of the crown. On the great festival of Nauroz, on the plains of Chowal Mugám, near Ardibíl, he assembled the principal nobles and officers to choose a king. "Choose," said he, "one of the princes of the blood, or some other you know to be great and victorious. It is enough for me that I have restored the glory of the throne and have delivered my country from Afg͟háns, Turks and Russians." But the unanimous request, repeated every day for a month, was that Nádir would accept the crown himself. At last he consented, on the conditions that the Shí'ah belief should be set aside, and the authority of the first four K͟halífahs be once more acknowledged. "Since the schism of Shí'ah has prevailed, this country has been in continual distraction, let us all become Sunnís and it will cease. But as every national religion should have a head, let the holy Imám Ja'far be the head of ours." The assembly finally consented to the change and a royal mandate issued to proclaim it. The ceremony of the coronation took place in a splendid hall; Nádir seated on a throne covered with jewels had the crown placed on his head, at, says the chronicler, 20 minutes past eight on the morning of the 26th February 1736 (1149 H.).* Coins were immediately struck in his name, bearing the inscription:

"Sikká bar zar kard nám-i-salṭanat rá dar jahán
Nádir-i-Irán zamín, o K͟husraw-i-gítí sitán,"

i. e., "the impression stamped on this coin proclaims throughout the world the sovereignty of Nádir of the land of Persia, the hero who subdued the earth."† The chronogram on the reverse, "Al K͟hairu fí má waqa'", forms the date of his accession, 1149 H.,* and reads: "That which has happened is the best." By the reversal of a letter "la" for "al" the wags made the translation read, "That which has happened is not the best."

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* [This should be 1148 H. The chronogram on the reverse of these coins forms the date 1148, which date is also given in figures. The obverse has the date 1149 in figures. The latter year commenced only on the 1st May 1736. The discrepancy in the dates is explained by Marsden (*Numismata Orientalia*, p. 473) by the supposition that the date on the obverse is that of the actual issue of the coin, while the date on the reverse is that of the accession. The date has been corrected in the list of coins, No. XXXV. ED.]

† [The couplet rather means: "Nádir (or the Wonder) of the land of Persia and the hero that subdued the earth has stamped the impression upon this coin for the sake of the fame of his sovereignty throughout the world." Ed.]

It is not intended to follow the subsequent career of Nádir Sháh, his invasion of India, his reign in Persia, and his tragic end. Whatever may be charged against his character, he certainly restored the throne of Persia to its former glory, and with all his failings, in many ways proved himself a great king. The feeble Ḥusain had brought the kingdom to its lowest ebb, it had in fact almost ceased to be a kingdom at all. Nádir did all that on the plains of Chowal Mugám he took credit for doing. He drove out the Afg͟hán, the Turk, and the Russian. He did more. He converted some of the most dangerous of his country's foes into its best defenders. He subdued the Buk͟htiyárís, daring tribes who occupied the rugged mountains of Lár, between Iṣfahán and Shústar, who had opposed the advance of Alexander, routed the armies of Rome, and given constant trouble for generations; and he made them into efficient soldiers, who did great service in his subsequent campaigns. He took Qandahár, though it cost him a siege of a year and a half, and conquered Kábul. At the latter place he left a contingent of his Qazalbáshís, where their descendants still occupy a quarter. He consolidated his empire, and then, as former rulers of his race had done, cast his eyes towards India, and in its invasion thought he saw the restoration to Persia of its ancient splendours and its ancient fame. We are accustomed to take the account of his invasion of India from the Indian historian's point of view. Judged dispassionately, his conduct generally appears to advantage. He was even generous to the conquered Mughal Emperor. Up to the period of his return from India, his countrymen at least might be proud of him. "Whether," as as Malcolm says, "we consider the noble and patriotic object which first stimulated his ambition, the valour and ability he displayed, the comparative moderation with which he used success, or the glorious deeds he had done, he is entitled to great, if not unqualified, admiration."

The last five years of his life, so fearfully clouded with suspicion and cruelty, are perhaps not quite the measure of the man. There is no doubt that his order, given in a moment of rage, to put out the eyes of his son Raẓá Qulí, preyed ever after on his mind. It must not be forgotten that this son had, during Nádir's absence, tried to usurp the throne, had made an organised attempt to take his father's life, and when Nádir in the most generous terms* had offered him pardon, if he would confess his fault, and invited him to wait till in the natural course of things he must succeed to the throne, the fierce

* See Hanway's contemporary story.

youth had, in the most insulting language, gloried in his attempt to rid the world of a tyrant. The act, however, not only "put out the eyes of Persia," but seems to have changed the nature of Nádir; and even partial historians describe the last years of his reign as exceeding in barbarity all that has been recorded of the most bloody tyrants. His attack on the religion of the people, if his attempt to diminish the power and wealth of the priests can be so called, was almost as fatally impolitic as his cruelties. His proceedings produced something like rebellion, and the spirit of insurrection changed Nádir's violence to fury. Towards the last he was maddened to desperation, and in 1160 H. he was finally assassinated by a committee of four principal officers of his court, including representatives of his own tribe and his own guards. Nevertheless his assassination was the death-blow of the mighty empire he had created, and disastrous anarchy almost immediately followed.

The death of Nádir saw the immediate rise of a powerful Afg͟hán empire. Few among his retainers were braver, more loyal or devoted than Aḥmad K͟hán, the Abdálí Chief, none more ready to revenge his death. But within a few months Aḥmad had founded a dynasty of his own, had changed the name of himself and his tribe, and become Aḥmad Sháh Durí Duráni, a name also destined to carry terror to India. Three or four years saw the province of K͟hurásán severed and converted into a separate principality. Mázandarán and Gílán before long were seized by the chief of the Qájárs, the governor of Áẕarbaiján declaired his independence, and almost half a century passed before Persia became a power again.

THE PUPPET KINGS.

The Ṣafwí dynasty, founded by rulers of the calibre of Sháh Ismá'il, and the great 'Abbás, than whom Persia had seen no greater since the days of the famous Sassanian, Naushirwán, practically ended with the capture of Iṣfahán by the Afg͟háns, after a life extending over nearly two and a quarter centuries. The descendants who were re-established by Nádir, as already noticed, were the merest puppets in his hands, and with his formal proclamations as Sháh, the dynasty dropped into oblivion. The puppet Ṭahmásp II. was murdered by Raẓá Qulí who had himself married a daughter of Sháh Ḥusain, and Raẓá's son Sháh Ruk͟h was therefore descended from the Ṣafwís on the mother's side. After the brief reign of Nádir's nephew, 'Adíl Sháh, and his brother, Ibráhím, both of whom had been slain, Sháh Ruk͟h was in

1162 H. (1740) raised to the throne. He was young, handsome, amiable, and popular, but his career was blasted by another chief, who also through the female line was a descendant of the Ṣafwís, one Sayyid Muḥammad, who seized Sháh Rukh, and before the latter could assemble his troops, blinded him, and proclaimed himself king with the title of Sulaimán II. The same year saw this Sulaimán put to death by a general of Sháh Rukh's, and the blind prince brought from the prison to the throne again. For awhile the unfortunate Sháh Rukh bore the title of prince, enjoyed the revenues of Mashhad, and the influence of Aḥmad Sháh Duráni was sufficient to convert Khurásán into a separate province for him and to guarantee its integrity. But its chiefs retained almost complete independence, and only acknowledged Sháh Rukh as their nominal suzerain.

Still another puppet of the Ṣafwí family was set up by the chief of the Bakhtiyárí and Zand tribes, a nephew of Sháh Ḥusain, with the empty title of Ismá'íl III.; but he was purely nominal under the Wakíl Karím Khán.

The whole of the doings of these petty rulers belong to an entirely subsequent chapter of history.

The inscriptions on the coins figured are in many cases somewhat elaborate. Sháh Ismá'íl describes himself as "Abú-l-Muẓaffar, Bahádur Khán, aṣ-Ṣafwí, as-Sulṭán, al-'Áḍil, al-Kámil, al-Hádí, al-Wálí," *the father of the victorious, the just and perfect Sulṭán, the guide, the governor.* Muḥammad calls himself "Bádsháh al-Ḥusainí, aṣ-Ṣafwí." Sulaimán says he is "Banda Sháh-i-Waláyát," *the slave of 'Alí,* while Ḥusain is "Kalb-i-Ástán-i-'Alí," *a dog of the threshold of 'Alí.* The baby king is "'Abbás ṣáliṣ, ṣání Ṣáḥib Qirán, Ẓil-i-ḥaqq", *the third 'Abbás, a second Muḥammad,* the shadow of God.*"

Coins Nos. 31, 32 and 33 are struck in the name of the Imám 'Alí Músá Raẓá, the first apparently at (?) Azindrán, or some similarly named place in Khurásán, the others in Mashhad; all probably during the nominal reign of Sháh Ṭahmásp II. Others, not described, are wanting dates or mints, some having neither. One is in the name of 'Ali سکه بنام علي رایج بحکم کمترین سلطنت گشت Another has جلوس میمنت مانوس دارالسلطنت اصفهان Others have the Shí'ah confession of faith on both sides.

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* [Rather: 'a second Tímúr,' who first assumed that attribute. Before this 'Abbás, the Emperor Sháh Jahán of Dehlí had similarly called himself, on his coins, 'the second Ṣáḥib Qirán.' Ed.]

Nos. 44, 45, and 46, are of Fatḥ 'Alí Sháh Qájár,* and do not belong to the series; and No. 48 is (to me at least) a doubtful coin. It appears to be of Ṭahmásp II., struck at Ḥawízah.

I have again to express thanks to the many friends who have sent me their coins to examine. In this case more especially to Mr. Rodgers of Amritsar, and to Mr. Furdoojee of Bombay. The latter gentleman's collection is especially rich in Ṣafwí, and many of his coins figure in this series.

GENEALOGY OF THE ṢAFWÍ DYNASTY.

According to the Zubdatu-t-Tawáríkh of Muḥammad Kamál, the descent of Sháh Ismá'íl was through the following line, from Músá Qásim, the seventh Imám:—Abú-l-Qásim Ḥamzah—Sayyid Abú-l-Qásim—Sayyid Muḥammad of Arabia—Fírúz Sháh Zarín Kuláh—Ahwáz al-Khás—Muḥammad al-Ḥáfiẓ—Ráshid—Shaikh Saláhu-d-dín—Shaikh Quṭbu-d-dín—Shaikh Saláh—Jabríl—Shaikh Ṣafíu-d-dín Isḥáq—Ṣadru-d-dín—Khwája 'Alí—Shaikh Ibráhím—Shaikh Junaid—married sister of Uẓan Ḥasan, of the Aq Kuyunlís.

Sulṭán Ḥaidar m. Martha, daughter of Uẓan Ḥasan by the Christian Lady Despina, daughter of Calo Johannes, Emperor of Trebizond.

Sulṭán 'Alí(*a*) Ibráhím(*b*) I. Sháh Ismá'íl
B. 891- | S. 908—D. 930 H.

II. Ṭahmásp I. Sám(*c*) Bahrám Ilkas(*d*) 5 daughters.
B. 920 | S. 930—D. 984 H,

IV. Muḥammad III. Ismá'íl II. Ḥaidar others
S. 985—D. 995 S. 984—D. 985

Ḥamzah(*e*) Ismá'íl V. 'Abbás I. daughter m. Isḥáq-Khán.
B. 967 | S. 994 D. 1037

(*a*) Proclaimed successor but seized and imprisoned by Ya'qúb and subsequently slain at Ardibíl.

(*b*) Fled to Gílán where he died.

(*c*) Rebelled in Khurásán, took Hirát 941 H. Afterwards fled across the Oxus.

(*d*) Rebelled 945 H. Fled to Turkey and then to Kúrdistán, but was delivered over to Ṭahmásp and killed.

(*e*) Assassinated 994 H.

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* By Markham and others this is incorrectly written Kájar.

V. 'Abbás I.
B. 967 | S. 994 D. 1073

Safí(*f*) Tahmásp(*g*) Razá(*h*) Amánu-lláh(*j*).

Fátimah(*i*).

VI. Sám (Sháh Safí)
B. 1020 S. 1037 D. 1052

VII. 'Abbás II.
B. 1043 S. 1052 D. 1077

VIII. Sulaimán Hamzah(*k*).
B. 1057 S. 1077 D. 1106

IX. Husain Daughter m. Mírzá Dáúd, chief priest of Mashhad. Daughter m. ?
S. 1106 A. 1135 D. 1141

XII. Tahmásp II.(*l*) Daughter m. Razá Qulí son of Nádir. XVII. Sulaimán II. (*n*)
XIX. Ismá'íl III.(*p*)

XIII. 'Abbás III.(*m*) XVIII. Sháh Rukh(*o*).

A Ghiljí Chief.

Mír Wís Mír 'Abdu-lláh(*q*).

X. Mahmúd XI. Ashraf.
S. 1134 D. 1137 H. S. 1137 killed 1142 H.

(*f*) Stabbed at the instigation of his father by Beh Bud Khán.

(*g*) Died before Safí was murdered.

(*h*) Blinded by order of his father and perished miserably.

(*i*) Killed by her father to spite his grandfather 'Abbás.

(*j*) Blinded by order of his father.

(*k*) An attempt, made to put this prince on the throne, defeated by a eunuch.

(*l*) Fled from Isfahán 1135 H. Nominal king in Farahábád 1139. Nominal under Nádir 1141. Put to death by Razá Qulí.

(*m*) Nominal at eight months old under Nádir 1145. Died 1148 H.

(*n*) Mírzá Sayyid Muhammad. Proclaimed himself king 1164. Put to death by Yúsaf 'Alí 1164.

(*o*) Born 1147, succeeded 1162. Blinded by Mírzá Sayyid Md. 1163. Nominally restored 1164. Independent in Khurásán 1165. Died 1210 H.

(*p*) Born 1155. Nominal under Karím Khán 1164. Died 1173 H.

(*q*) Slain by Mahmúd.

Tribe of Afshár or Aushár.

Imám Qulí.

XIV. NÁDIR SHÁH (Nádir Qulí)
B. 1100 S. 1149 Murdered 1160 H.

Ibráhím Qulí.

Raẓá Qulí m. daughter of Sháh Ḥusain.

SHÁH RUKH

XV. 'ÁDIL SHÁH ('Alí Qulí).
S. 1160 Blinded by XVI, 1162 killed 1162

XVI. IBRÁHÍM (r).
S. 1162 killed 1162.

CONTEMPORARY RULERS.

A. H.	A. D.	Ṣafwís of Persia.	Uzbaks in Transoxania &c.	'Usmánlí Sulṭáns of Turkey.
886	1481	...	SHAIBÁNÍ DYNASTY....	Báyazíd II. bin Muḥd.
906	1500	...	Muḥd. Shaibání ...	
908	1502	Ismá'íl I. ...	...	
916	1510	...	Köchkúnji ...	
918	1512	...	...	Salím I. bin Báyazíd.
926	1520	...	...	Sulaimán I. bin Salím
930	1523	Ṭahmásp I. ...	...	
937	1530	...	Abú Sa'íd ...	
940	1533	...	'Ubaidu-lláh ...	
946	1539	...	'Abdu-lláh ...	
947	1540	...	'Abdu-l Laṭíf ...	
959	1551	...	Naurúz Aḥmad ...	
963	1555	...	Pír Muḥammad I. ...	
968	1560	...	Iskandar .	
974	1566	...	...	Salím II. bin Sulaimán
982	1574	...	...	Murád III. bin Salím
984	1576	Ismá'íl II. ...	...	
985	1577	Muḥammad, bin Ṭahmásp	...	
991	1583	...	'Abdu-lláh II. ...	
994	1585	'Abbás I, bin Muḥammad	...	
1003	1595	...	...	Muḥd. III. bin Murád
1006	1598	...	'Abdu-l-Múmin ...	
1007	1599	...	Pír Muḥammad II. ..	
			ASTRAKHÁN DYNASTY	
1007	1599	...	Báqí Muḥammad ...	
1012	1603	...	...	Aḥmad I. bin Muḥd.
1014	1605	...	Wálí Muḥammad ...	
1017	1608	...	Imám Qulí ...	
1026	1617	...	...	Muṣṭafá I. bin Muḥd.
1027	1618	...	...	'Uṣmán II. bin Aḥmad
1031	1622	...	...	Muṣṭafá I. restored.
1032	1618	..	...	Murád IV. bin Aḥmad
1037	1627	Sháh Ṣafí ...	...	
1049	1640	...	...	Ibráhím I. bin Aḥmad
1050	1640	...	Nádir Muḥammad	

(r) Formerly Governor of 'Iráq.

A. H.	A. D.	Ṣafwís of Persia.	Uzbaks in Transoxania &c.	'Uṣmánlí Sulṭáns of Turkey.
1052	1642	'Abbás II. bin Ṣafí ...	...	
1057	1647	...	'Abdu-l-'Azíz ...	
1058	1648	...	...	Muḥd. IV. bin Ibráhím
1077	1666	Sulaimán I. bin Abbás II.	...	
1091	1680	...	Subḥán Qulí ...	
1099	1687	...	...	SulaimánII.binIbráhím
1102	1691	...	...	Aḥmad II. bin ditto
1106	1695	Ḥusain bin Sulaimán	...	Muṣṭafá II. bin Muḥd.
1114	1702	...	'Ubaidu-lláh I. ...	
1115	1703	...	...	Aḥmad III. bin Muḥd.
1117	1705	...	Abú-l-Faiz ...	
1135	1722	Maḥmúd (an Afghán)...	...	
1138	1725	Ashraf (Ditto) ..	...	
1142	1729	Ṭahmásp II. (Nominal)	...	
1143	1730	...	...	Maḥmúd I. binMuṣṭafá
1145	1732	'Abbás III. (Nominal)	...	
1149	1736	Nádir Sháh ...	...	
1160	1747	'Ádil Sháh ...	'Abdu-l-Múmin ...	
1162	1748	Ibráhím ...	...	
1162	1748	Sháh Rukh ...	...	
1164	1750	Sulaimán II. ...	...	
1164	1751	Ismá'íl III. (Nominal)	'Ubaidu-lláh II. ...	
1167	1753	Md. Karím Khán ...	Muḥammad Raḥím...	
1168	1754	...	...	'UṣmánIII.bin Muṣṭaf
1171	1757	...	...	MuṣṭafáIII.bin Aḥma

ṢAFWÍS OF PERSIA.

I. Ismá'íl as-Ṣafwí. Æ. 1·12—143 grains. Níshápúr. No date Mr. Rodgers.

Obv.	Rev.
Within circle لا اله الاالله	السلطان العادل
محمد رسول الله	الكامل الهادے الوالے ابو المظفرشاه
علي ولي الله ،	اسمعيل خلد الله
In segment round علي حسن	بهادرخان الصفوے ملكه
علي حسين محمد جعفر علي موسى	و سلطانه نيشاپور
محمد علي محمد حسين	

Ditto Æ. 1·0. Isfaráin, and Tabríz Mr. Furdoonjee.

II. Ditto Æ. 1·09—144 grains. Mashhad. No date. Mr [Rodgers

The same formula in square with the names of the 12 Imáms round on four sides.	The same inscription, but ضرب مشهد

	Ditto.	Æ.	1·0—72	grains.	Sabzwár.	Mr. Furdoonjee.
	„	„	·9—70	„	Níshápúr.	„
	„	„	·9—74	„	Aláward.	„
	„	„	1·0—71	„	Nisá.	„
III.	Ditto.	Æ.	·9—69	„	Hirát. 929 H.	My cabinet.

Formula in circle. Names of Imáms in four segments round.	.... Area الهادي ابو المظفر شاه اسمعيل بهادرخان خلد الله تعالى ملكه ۹۲۹ In centre ضرب هراة

IV. Ditto. Æ. 1·0—68 grs. Nímroz. No date. My cabinet.

Similar formula.	Similar inscription, but ضرب نيمروز

Ditto. Nímroz. * 29 H. Mr. Furdoonjee.

V. Ditto. Æ. 1·1—150 grains. Hirát. 924 H. My cabinet.

The same formula in hexagon and six segments round.	Area ... طان العادل الو . لے .. كامل .. هادي ابو المظفر شاه اسمعيل بهادر خان الصفوي .... نه In centre ضرب هراة ۹۲٤

Ditto. Æ. ·85—17 grains. Tabríz. No date. Mr. Furdoonjee.

The same formula in ornamental circle and segments round.	The same, but in centre. شاه اسمعيل ضرب تبريز

Ditto. Æ. 8—120 grs. Yazd, 929 H. Mr. Furdoonjee.

The same formula in square as No. II.	Area the same, but in ornamented central circle ضرب ۹۲۹ يزد

Ditto. Æ. 1·1—70·5 grains. Aláward, no date. Mr. Furdoonjee.

The same as No. V.	The same, but in centre shield. ضرب الى ورد

Ditto. Æ. ·93—72·5 grains. Nisá. Mr. Furdoonjee.

The same, in square, as No. II.	The same, but in centre lozenge سلطان اسمعيل شاه

VI. Ditto. Æ. ·75—72 grains. Tabríz, 908 H. Mr. Furdoonjee.

In central circle. علی حسن محمد علی حسین محمد علی محمد جع .. علی محمد موسے Round الله الا .... لي الله	.... ،..... ظفر اسمعيل شاه • Area • الله ۹۰۸ ضرب تبریز خلد ملکه

Ditto. Astarábád, Aláward, without date.

VII. Sháh Ṭahmásp I. Æ. ·57—80 grains. Hirát, no date. My cabinet.

The same formula with quarterfoil and 4 segments round. علي حسن حسين علي جعفو محمد موسی علي محمد علي حسن محمد	Area السلطان العادل الكامل الهادے ابوالمظفر شاه طهماسپ خان بهادر الصفوي الله و سلطانه • خلد تعالی ملکه In centre ضرب هراة

Ditto. Æ. ·95—82 grains. Hirát, 941 H. Mr. Furdoonjee.

VIII. Ditto. Æ. 82—45 grains. Hirát, no date. My cabinet.

The same formula arranged in square.	The same inscriptions.

IX. Ditto. Æ. ·87—70 grains. Astarábád, no date. Mr. [Rodgers.

The same formula.	Area the same, but in centre. طهماسپ شاه ضرب استراباد

X. Ditto. Æ. 1·05—78 grains. Nímroz, no date. Mr. Rodgers.

The same formula.	Area the same, but centre star. ضرب نیمروز

XI. Ditto. Æ. ·78—45 grains. Mashhad, 960 H. Mr. Rodgers.

The formula in and round an almond shaped area.	Area العا ... لهادے شاه طهماسپ ابولمظفر • الله ضرب مشهد بها .. خا. ملکه و سلطانه In centre امام رضا ۹۶۰

Ditto. Æ. ·85—120 grains. Yazd, 940 H. Mr. Furdoonjee.

In ornamented circle the 12 Imáms forming star and usual formula round.	Area as above. بادر خان In centre lozenge طهماسپ ب زد ضرب ۹۴۰

Ditto. Æ. ·85—120 grains. Tabríz, no, date. Mr. [Furdoonjee.

The same formula arranged in square like No. II.	The same area, but in centre circle طهماسپ شاه خلد تبریز

Ditto. Æ. ·85—121 grains. Tabríz, no date. Mr. [Furdoonjee.

The same.	The same, but centre square ضرب تبریز

XII. Ditto. Æ. ·85—120 grains. No mint or date. Mr. [Furdoonjee.

علي حسن محمد علي حسين...... علي م........... علي جع.........	خان ... هماسپ بهادر شاه

Ditto Qandahár, Sulṭání, without dates.

XIII.* Sháh Ismá'íl II. Mír Ṭahmásp. AR.. ·85—72 grains. Qazwín. [No date. My cabinet.

کرست ما بمغرب اماما لامسر علی و امار بمام ست	ابوالمظفر بن طهماسپ الصفوی اسمعیل شاه ... المواحد بن قز ... ین

Ditto. Æ. ·80-71 grains. Qazwín, no date. Mr. [Furdoonjee.

XIV. Muḥammad (Khodábanda). AR. ·9—71 grains. Ja'farábád, 985 H. My cabinet.

In centre لااله الاالله محمد رسول الله علي ولي الله round علي حسن حسين علي...جعفر	In ornamental circle عليه السلام و ابائه غلام امام مهدی محمد سلطان ابوالمظفر محمد بادشاه ضرب جعفراباد round الحسني الصفوي خلدالله ملكه سنة ٩٨٥ ....

Ditto. Æ. ·9—71 grains. Ja'farábád, no date. Mr. Furdoonjee.

The same.	The same but in simple circle.

Ditto. Æ. ·9—71 grains. Qazwín, 986 H. Mr. Furdoonjee.

The same.	The same, but outer inscription in ornamental segments.

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* [The obverse of No. XIII probably reads :

ز مشرق تا بمغرب گر امام ست علی وآل او مارا تمام ست

which is a Persian verse. Ed.]

XV. Sháh 'Abbás I. Æ. 1·1—141 grains. Counterstruck, Qandahár, 1029 H. Mr. Rodgers.

The same formula as No. I.	العادل ... ...الهادي الوالي ابوالمظفر ...... الصفوے ٠٢٩ ، غا..زي Counterstruck عدل قندهار

XVI. Sháh 'Abbás II. Æ. ·8—112 grains. Tabríz, 1058 H. Mr Furdoonjee.

The centre لااله الاالله محمد رسول الله علي ولي الله Round علي حسن حسين علي محمد جعفر موسی علي محمد علي حسن محمد	بگیتی سکهٔ صاحبقرانی ١٠٥٨ زد از توفیق حق عباس ثانی ضرب تبریز dotted margin.

Ditto. Æ. ·9—101 grains. 1053 H. Æ. 1·0—138 grains. 1076 H. Æ. 1·0—70 grains. Æ. 1·3—135. grains. No date. All of Tabríz and with similar inscriptions.

Ditto. Æ. 1·0—101 grains. Abrawán.* 1041 and 1065 H. My cabinet.

Ditto. Æ. 1·0—101 grains. Tiflís 1053 H. My cabinet.

XVII. Ditto. Æ. ·9—116 grains. Ganjah 1052 H. „

لااله الاالله محمد رسول الله علي و ...	شاه ولایت بنده عباس گنجهٔ ١٠٥٢ ضرب

XVIII. Ditto. Æ. 1·1—70 grains. Tabríz, 1052 H. My cabinet.

The same inscriptions.	As No. XVI, but larger.

XIX. Sulaimán I. bin 'Abbás II. Æ. ·95—110 grains. Nakhjiwán, 1097 H. Mr. Furdoonjee.

The same formula.	شاه ولایت بنده ١٠٥٧ سلیمان نخجوان ضرب

Ditto. Nakhjiwan, 1098, 1100 H. Abrawán,* 1102, 1103, 1105 H. Mr. Furdoonjee.

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* [Perhaps Írwán ايروان Ed.]

Ditto. Ganjah, 1103, ***4 H. Tabríz, 1104 H. All similar. Mr. Furdoonjee.

XX. Ditto. Æ. ·95—147 grains. Qandahár, 1078 H. My cabinet.

Persian lion and sun.	قندهار فلوس ١٠٧٨ ضرب

XXI. Sháh Ḥusain bin Sulaimán. AR. 1·0—79 grains. Iṣfahán, 1133 H. My cabinet.

The same formula as No. XVI.	شاه ولايت ١١٣٣ بندهٔ حسين ضرب اصفهان

XXII. Ditto. AR. 1·03—75 grains. Mashhad, no date. My cabinet.

The same formula.	علي كلب آستان حسين ضرب مشهد

XXIII. Ditto. AR. 1·1—68 grains. Tabríz, 1134 H. My cabinet.

The same formula.	The same inscription, but with ornamental margin.

XXIV. Ditto. AR. ·95—83 grains. Tiflís, 1131 H. Mr. Furdoonjee. The same, with dotted margins.

Ditto. AR. 95—82 grains. Tabríz, 1130, 31, 32, and 33 H. Mr. Furdoonjee.

Ditto. AR. 1·05—83 grains. Qazwín, 1131 H. Mr. Furdoonjee.

XXV. Ditto. AR. 1·1 × ·75—123 grains. Iṣfahán, 1126 H. Mr Furdoonjee.

لااله الاالله محمد علي رسول الله ولي الله	شاه ولايت بندهٔ حسين ١١٢٦ ضرب اصفهان

XXVI.* Maḥmúd, an Afghán. Æ. ·95—66 grains. Iṣfahán, 1135 H. My cabinet.

لااله الاالله محمد ..سو... الله	.... يردون شاه محمود جهانگير [١١٣٥ س..نيا] ضرب اصفهان

XXVII. Ditto. Æ. 1·1—111 grains. Iṣfahán, 1134 H. Mr. Furdoonjee.

The same formula, but date ١١٣٥	...هروهه شاهنشهي ..سدا محمود عالمشد كه نقد [ان ليس] از فيض عش مسلم شد ضر... اصفهان

XXVIII. Ashraf, an Afghán. Æ. 1·0—67 grains. Qazwín, 1139 H. My cabinet.

The same, but date, ١١٣٩	حق شعار از الطاف شاه اشرف بر زلقيس شد سكه خاز... ے ... قزوين ١١٣٩

Ditto. Æ. 1·15—111 grains. Iṣfahán, 1137 H. Mr. Furdoonjee.

The same inscriptions, but date 1137.	مهرو مه طلا ونقره [..بوس] شد سرير آفتاب ... اشرف سكه برزر شد ... اصفهان

XXIX. Sháh Ṭahmásp II. (abdicated). Æ. 1·05—70 grains. Ṭabríz, 1135 H. My cabinet.

The same as No. XVI.	بگيتي سكة صاحبقراني زد از توفيق حق طهماسپ ثاني ضرب تبريز ١١٣٥

XXX. Ditto, (nominally restored). Æ. 1·1—83 grains. Iṣfahán, 1142 H. Mr. Furdoonjee. The same inscription.

A similar coin, but with dotted margins. Iṣfahán, 1142 H. Mr. Furdoonjee.

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* [A very nearly identical coin is given in Marsden's *Numismata Orientalia*, p. 470, No. DLXXIV. The couplet on these coins, probably, runs thus:—

سكه زد از مشرق ايران چو قرص افتاب * شاه محمود جهانگير شهاعت انتساب

Marsden reads the two last words شاه انساب which do not scan. The meaning is: "Sháh Maḥmud, the conqueror of the world, with reference to his bravery, has struck this coin from the east of Írán, like the disk of the sun." Ed.]

Coins struck in the name of the Imám 'Alí Músá Raẓá.

XXXI. 'Alí Músá Raẓá. Æ. 1·1—78 grains. Azindrán, 11** H. My cabinet.

لااله الاالله علي	از خراسان سکه بر زر شد
محمد رسول الله ولي	بتوفيق خدالضرو اصداد
الله	شاه دين علي موسى رضاء
	...ب از ندران ۱۱

XXXII. Ditto. Æ. 1·0—73·5 grains. Mashhad, *143 H. My cabinet. Similar inscription.

XXXIII. Ditto. Æ. ·9—174·5 gr. Mashhad, no date. My cabinet.

	الرضا
The same.	يا علي ابن موسى
	ضرب مشهد

Ditto. Æ. ·95—178·5 grains. Mashhad, 1141 H. Mr. Furdoonjee.

XXXIV. 'Abbás III. bin Ṭahmásp. Æ. 1·05—83 grains. Shíráz, 1145 H. My cabinet.

The same as No. XVI but larger.	سکه بر زر زد بتوفيق اله
	در جهان - ظل حق عباس ثالث
	ثاني صاحبقران ۱۱۴۵
	ضرب شيراز

Ditto. AR. 1·1—83 grains. Iṣfahán, 1145, 1146 H. Mr, Furdoonjee. Similar inscriptions.

Coin struck in the name of 'Alí. Æ. ·85—68 grains. No Mint 114* H. Mr. Furdoonjee.

The usual formula in dotted circle.	رائج بحکم کمترين
	سلطنت گشت
	سکة بنام علي

XXXV. Nádir Sháh. Æ. ·95—82 gr. Mashhad, 1150 H. My cabinet.

بتاريخ الخيرفيما وقع	سکه بر زر کرد نام
۱۱۵۰	سلطنت را در جهان - نادر
A chronogram referring to the date	ايران زمين و خسرو گيتي ستان
of Nádir's accession A. H. 1148.	ضرب مشهد

XXXVI. Ditto. Æ. ·9—175 grains. Tabríz, 1153 H. My cabinet.

تبريز	شاهان نادر صاحبقران
دارالسلطنت	شاه
ضرب	سلطان بر سلاطين جهان
۱۱۵۳	

Ditto. Similar coins of Tabríz, 1151, 1154, 1157 and 1158, Mashhad 1151, Iṣfahán 1157, 1156 H. Mr. Furdoonjee.

XXXVII. Ditto. Æ. 1·0—67 grains. Tiflís, 1151 H. Mr. Furdoonjee.

مانوس الخیر فیما وقع	The same as No. XXXV, but
میمنت	ضرب تفلیس
تاریخ جلوس	
١١٥١	

XXXVIII. Ditto. Æ. ·8—105 grains. Mashhad, 1151 H. Mr. Furdoonjee.

نادر	خلد الله
السلطا	ملکه مشهد
ن	ضرب ١١٥١

Ditto. Æ. ·7—105 grains. Iṣfahán, 1151 H. Mr. Furdoonjee.

XXXIX. Sháh Rukh, (grandson of Nádir). Æ. 1·0—356 grains. Mashhad, 1161 H. Mr. Furdoonjee.

	خلد الله
السلطان	ملکه مقدس
شاهرخ	مشهد
	.. ب ١١٦١

XL. Ditto. Æ. ·9—177 grains. Mashhad, **63 H. Mr. Furdoonjee.

مقدس	صا ٦٣ • • ـــے
مشهد	بنام شاهرخ سکه زد
ضرب	یران گرفت از سرخ ...
	.. ب

XLI.* Muḥammad Karím Khán (Zandi). Æ. ·95—70 grains. No mint or date. My cabinet.

لااله الا الله	شد آفتاب ماه زر و سیم
محمد	درجهان ـ سکه امام بحق صاحب الزمان کر..
ر .. سول الله علی	....
ولي الله	
Counterstruck رائج	

XLII. Ditto. Æ. ·95—68 gr. Qazwín, 1175 H. Mr. Furdoonjee.

	یا کریم
Similar formula.	دارالسلطنت قزوین
	ضرب
	سنه ١١٧٥

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* [The true reading of the obverse, from better preserved coins, is given by Marsden, *Num. Orient.*, p. 481. Ed.]

XLIII. Ditto. Æ. ·8—55 grains. Shíráz, **90 H. Mr. Furdoonjee.

[باعي]	The same as No. XLI.
دار[العلم شيرا] ز	
ضرب	

Ditto. Æ. ·8—67 grains. Shíráz, **75 H. Mr. Furdoonjee.

شيراز	The same as No. XLI.
دارالعلم	
ضرب	
...۷۵	

XLIV. Fatḥ 'Alí Sháh (Qájár). Æ. ·95—138·5 grains. Mashhad, 1244 H. My cabinet.

عليه السلام	سکه فتحعلی شه
ضرب ۱۲۴۴	خسرو صاحبقران
مشهد امام	

XLV. Ditto. Æ. ·95—158 gr. Kirmán, 1219 H. Mr. Furdoonjee.

کرمان	شاه قاجار
دارالامان	فتحعلی
ضرب	السلطان بن السلطان
۱۲۱۹	

XLVI. Ditto. Æ. ·85—44 gr. Shíráz, 1203 H. Mr. Furdoonjee.

شيراز	Similar inscription.
دارالعلم	
ضرب	
۱۲۰۳	

Ditto. Æ. ·50—37 grains. Yazd, no date. Mr. Furdoonjee.

يزد	Similar inscriptions.
العبا	
دارده	

XLVII. (?) Muḥammad Khán. Æ. ·75—100 grains. Astarábád, 1173 H. Mr. Furdoonjee.

يا صاحب	الله
الزمان	خلد
	ملکه استراباد
	ضرب ۱۱۷۳

XLVIII. (?) Sháh Ḥusain. Æ. ·8—57 grains. Ḥawaizah, no date. My cabinet.

In circle الله	In circle حويزه
لي ولي	... ب
Round.............. لااله الاالله	Round بنده ولايت حسين

Antiquities at Nagarí.—*By* KAVI RÁJ SHYÁMAL DÁS, M.R.A.S., F.R.H.S. *Translated by* BABU RÁM PRASÁD. (*With two Plates.*)

Nagarí is a small village in Mewár, and is situated on the east or right bank of the Berach, about six miles north-east of Chitoṛ. At one time it was part of the jágír of the Ṭhákur of Bassí, but it is now included in the estate of the Ráo of Bedlá who belongs to the Guhilat or Gehlat clan. The name of this clan is derived from Guhil, the son of the Bappá Ráwal who in Samvat 784, A. D. 728, according to Col. Tod, or S. 791, A. D. 735, as I believe, took Chitoṛ from Man'morí, the last of the Morí or Pramar dynasty.*

Though we do not know the dates of the foundation, or the destruction of Nagarí, yet the latter event must have occurred before the time of Bappá who lived more than eleven centuries ago; and it would seem from two inscriptions at Nagarí being in the Southern Aśoka character that the city was flourishing before the Christian era. The inhabitants point out the remains of an ancient fort at Nagarí, and say that its moat was formed by a ravine lying to the eastward. An examination of the spot shows that some building must have stood there, for large bricks are occasionally dug up in the neighbourhood. The north-east and south quarters of Nagarí also contain many isolated specimens of ancient architecture. The old rampart of the town is said by the villagers to be represented by a crescent-shaped embankment which skirts Nagarí, commencing on the south at the river and encompassing the south-east, east and north-east quarters, and ending at the north on the river bank again. The entrance to the old city is traceable on the road leading to Bassí. In some places we find old mortar floorings, and sometimes masonry gháṭs are exposed to view by the erosion of the river banks.

Two earthen vessels measuring 12 feet in height and 3 in diameter, with sides an inch thick, are to be seen in the shaft of a well sunk by a barber. Such vessels called *nánd* (नांद), 3 to 4 feet high and 1½ in diameter, are manufactured at the present day by potters on their wheels, but those two old vessels seem to have been constructed by joining several layers, each 4 inches high, and then baking them in a kiln. The rims of similar vessels may be seen peeping out from the ground in two other places.

Háthioṃ ká báṛá.

About half a mile east of the village there is an open rectangular enclosure which goes by the above name, *i. e.*, the elephant-enclosure.

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* Tradition says that Chitrang Morí removed to Chitoṛ, on Nagarí having been doomed to destruction by the curse of an ascetic.

Its walls are composed of large slabs of a greyish limestone, admirably put together in five successive layers. The height of the wall is 9 ft. 4 in., and it is 3 ft. 2 in. thick at bottom, and 1 ft. 4 in. at top. The breadth of the slabs of the lowest layer is 2 ft. 9 in., of the 2nd, 1 ft. 8 in., of the 3rd, 2 ft. 7 in., of the 4th, 1 ft. 3 in., and of the 5th, 1 ft. 4 in. Their length varies from 7 ft. to 14 from the top to the bottom. The outer measurement of the enclosure is 300 ft. 4 in. by 154 ft. 4 in., and the inner is 291 ft. by 148 ft. 6 in. The entrance is at the southern side; the northern side is in a state of dilapidation, owing, according to the villagers, to the Ṭhákur of Bassí's having taken away the stones to erect other buildings with.

Úbh'díwal, or Akbar's Lamp.

About a mile north-east of Nagarí there stands a pyramidal tower (Plate V), built of the same kind of stone, and constructed in the same way as the Háthioṃ ká báṛá. It is 14 ft. 1 in. sq. at the outside base, and 3 ft. 3 in.sq. at the apex. Its height is 36 ft. 7 in., and it is composed of 21 layers of large blocks piled one on the other. The tower is solid for 4 ft., then hollow for 20 ft., and solid again up to the top. The floor of the cavity, or chamber, is 4 ft. sq., and it has 7 openings to admit light. The window facing the east is 2 feet. by 1, 3 in.; of the two on the west one is 3 ft. 3 in. by 3 ft., and the other 2 ft. by 1, 9 in.; one window on the north is 2 ft. by 1, and the other is 2 ft. 3 in. by 2 ft., and so also are the windows on the south.*

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* These measurements were reported to the author by Ṭhákur Jagannáth Singh the Hákim, or Ráj-official at Chitoṛ. Tod has two references to Akbar's lamp. At vol. I, p. 325, he says "the site of the Royal (Akbar's) Oordoo or camp, is still pointed out. It extended from the village of Pandowly along the high road to Bussie, a distance of ten miles. The head-quarters of Akbar are yet marked by a pyramidal column of marble, to which tradition has assigned the title of Akbar ka dewa, or Akbar's lamp." He adds in a note. "It is as perfect as when constructed, being of immense blocks of compact white limestone, closely fitted to each other, its height thirty feet, the base a square of twelve, and summit four feet, to which a staircase conducts. A huge concave vessel was then filled with fire, which served as a night beacon to this ambulatory city, where all nations and tongues were assembled, or to guide the foragers." The other reference is at vol. II, p. 755. There he expresses his regret that, owing to the results of an accident, he was unable to climb the staircase "trodden no doubt by Akbar's feet." But in fact there is no inner staircase. Kaviráj Shyámal Dás writes as follows: "There is no flight of steps to reach even the highest part of the hollow chamber, though there are projecting portions of the blocks composing the pyramid on which the feet can be rested. If any one wants to get to the very top, he must get out at the highest window and then somehow or other scramble up." The Kaviráj observes that the fact of there being no interior staircase corroborates his view that the tower has not been built by Akbar, though he may have used it as a beacon. There is no tradition about its

This pyramid is call'ed '*U'bh'díwal*' or the 'vertical lamp', and is said to have been erected by Akbar as a beacon lamp (for burning cotton seeds socked in oil placed in a huge cup kept on the summit), to denote the head-quarters of his camp when pitched there to reduce the fort of Chitoṛ in S. 1624 (A. D. 1568). Notwithstanding the authors of the Akbar Námah, Ṭabaqát i Akbarí, Iqbál Námah Jahángírí and Farishta say nothing about it, yet it may be that Akbar did employ the column for placing on it the signal light of his camp, reasonably considering it better adapted to this purpose than any new thing which he could make.

From certain remains found to the north of Nagarí in the bed of the Berach, it may be inferred that a bridge had been thrown across the river, and the people say that its débris were used in that over the Gambhírí which flows past Chitoṛ. But my own investigations show that the latter could not have been entirely constructed in this way, as it contains also portions of some old shrines, *e. g.*, the stone tablet bearing the Inscriptions of the temples founded by Ráwals Tej Singh and Samar Singh.*

Further, the inhabitants of Nagarí have a belief that the materials of its ancient structures were used in the erection of the fort and the buildings of Chitoṛ. This carries a certain amount of truth with it, inasmuch as traces of the *débris* of Nagarí village attract the tourist's notice in the temples and ruins of Chitoṛ.†

origin, but the similarity of its architecture with that of the Háthioṃ ká báṛá would point to a contemporaneous date of the two structures. He also informs me that the word U'bh'díwal is a Mewárí term. *U'bh* in that dialect means 'standing' or 'vertical', *e. g.*, *úbhá honá* means 'to stand up'. Díwal is equivalent to Hindí *díwaṭ* 'a lamp' and seems to be derived from the two words *díp* and *álay*. *Note by Mr. H. Beveridge.*—[The staircase, spoken of by Tod, must have been an outer one, probably a wooden structure, which appears to have perished. An inner staircase, even if there could have been one in the narrow chamber of 4 feet square, would have been useless for the purpose of reaching the summit, between which and the roof of the chamber there are 12 feet of solid masonry. As Akbar used to keep a beacon on its summit, it is clear that once there must have existed an outer staircase by which the summit could be reached. Akbar himself may have got it made for his beacon. Ed.].

* Paper on the Prithí Ráj Rásá, p. 17, No. I, p. 1, B. A. S. Journal for 1886.

† Tod, II, p. 750, says that two temples in Chitoṛ, erected by Ráná Khumbo, and his wife Mírá Báí, are entirely constructed from the wrecks of more ancient shrines, said to have been brought from the ruins of a city of remote antiquity, called Nagara, three kos northward of Chitoṛ. He adds in a note "I trust this may be put to the proof; for I think it will prove to be Takshac-Nagara, of which I have long been in search; and which gave rise to the suggestion of Herbert that Chitor was of Taxila Porus."

Old coins are sometimes picked up at Nagarí during the monsoon, when the dust and the surface soil get washed off. Four such coins likely to interest numismatists are sent with this paper for the Society's Museum.* Major-General Cunningham fancies from the finding of some ancient Sibi coins† at Chitoṛ, that it must have belonged to the Sibi kings whose dominions lay towards the Panjáb, and that Jayatura, the metropolis of the Sibi territory, may be Chitoṛ.

I shall now speak of two old inscriptions (see Plate V*a*) corroborating the evidence of the antiquity of Nagarí: their squeezes brought by Pandit Rám Pratáp Jotishí are sent herewith.

Inscription I.

This is on a slab on the right hand side of the door or entrance leading down to a tank in the village of Ghasundí, about 4 miles N. E. of Nagarí.‡ The tank was completed on the 3rd Baisákh Sudi S. 1566 (19 April 1510), by Singár Debí, wife of Maháráná Rái Mall.

The slab measures 3 ft. 7 in. × 1 ft. and contains 3 lines of 15 letters each, but unfortunately the 13th letter in each line is so close behind a pillar that an impression could not be taken of it. See Plate I.

Having failed to make out any satisfactory sense of the inscription, I had recourse to my able and learned friend Mr. Bendall, Prof. of Sanskrit in University College, London, and I am deeply indebted to him for the kindness with which he has replied to me on the 27th October last as follows:

"The character is in the main the oldest found character known. We usually call it the 'Southern Aśoka.' All the rock edicts of Aśoka south of the Panjáb are in this character They are in a kind of Prákrit or Páli, however. This is in a sort of popular Sanskrit, probably what Páṇini means when he speaks of the *bháshá* of his time. Some scholars call it the 'Gáthá dialect.' The Mahávastu a great Buddhist book, published by M. Senart at Paris, is, in the main, in this form of speech.

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* [The coins have been received, but nothing can be made out of them, as the devices and inscriptions are quite obliterated. Ed.].

† Archæological Survey Reports, XIV, 45.

‡ [In a note, subsequently received, the author adds: "*Entrance* of the tank must be taken in its literal sense. In Rájpútáná we have numbers of *báolí* (باولي) or reservoirs of water, which have only one descent; and over the *gháṭ* one, or sometimes two-storeyed structures are built; and in some cases, as in the tank in question, literally a doorway leads to the water's edge. The inscription exists on the right hand side of the descent, inside the entrance, towards the body of the water. There are no surrounding walls, raised above the ground level, but the parallel sides of the descent are shaped like walls." Ed.]

You will see from my transcription that it is not pure Sanskrit; but it differs from Páli and most Prákrits by having the letters श and ष, while they have only स—

The stone is evidently broken on both sides and I can make no sense of the first line except a, probably, man's name *Páraśara.*

From lines 2 and 3 it would seem that a "hall of worship" was made to Sankarshaṇa (Siva) and Vásudeva, with a wall or rampart (*prakára*).

(1.) न ग ज य ने न पा र श र ? त ण स
(2.) ज ना भ ग व भ्या स क ष ण वा सु दे वा भ्यां
(3.) भ्यां पू ज श ला प्रा का रों ना रा य ना ष ठ का

?= Sansk. Vaṭaká Náráyaṇa, surrounding, sheltering."

Mr. Bendall supposes Sankarsan to stand for Siva and correctly too, since the term is sometimes applied in this sense; but generally it is used to signify *Bal Deo*, the elder brother of *Krishṇa* or *Vásudeo* (son of *Vasudeo*). Thus we see that a hall of worship was made to *Bal'deo* and *Vásudeo*, from which the inference may be drawn that they were regarded with veneration at that period, and that idol worship was in vogue among the Vedic people.

Inscription II.

Found on the river bank near Nagarí, evidently broken on both sides, measuring 1 ft. × 8½ in. and marking 8 letters of the same character as the preceding. See Plate I. They read

व भू ता ना द या य
ता

One letter स has been evidently defaced from the beginning, thus making सव (सर्वे) भूतानां दयाय—ता = meaning "mercy to all creatures," which was one of the formulæ of the Jains.

I also give a third inscription which is of modern date and records the making of the tank above referred to.

[From a very good squeeze, subsequently sent by the Kaviráj, and from which Plate V*a* has been prepared, the fragments of the two inscriptions would seem to read thus:

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
I.	* *	ता	न	गा	जा	य	ने	न	पा	रा	श	रि	पु	त	ण	स	* *
	* *	जि	न	भ	ग	व	भ्यां	सं	क	र्ष	ण	वा	सु	दे	वा	भ्यां	* *
	* *	भ्यां	पू	जा	शि	ला	प्रा	का	रो	ना	रा	य	ण	वा	टे	का	

In the first line, the 1st letter is partially broken away, but sufficient remains to show it to have been *tá;* the 3rd letter is *gá* or *grá* rather than *ga;* the 4th letter, and the 3rd of the third line are alike, both being *já;* the 5th letter may possibly have an anuswára (ं); the 11th letter is distinctly *ri*, with what looks like a dot within the angle of the vowel. In the second line, the 1st letter again is partially broken, but the vowel *i* is distinctly visible; the 2nd letter is more probably only *na* (not *ná*). In the third line, the 4th letter is distinctly *śi*, the 12th is *ṇa*, and the 14th is *ṭe*. The latter would seem to stand for *ṭi;* for the word intended is probably *váṭiká*, 'an enclosure' or 'a garden.' The second line would seem to mention the Jina (Mahávíra) and Bhagavá (Buddha) as well as the two brothers Sankarshaṇa (Baladeva) and Básudeva (Kṛishṇa). At the beginning of the three lines, as well as at the end of the first two lines some portion of the inscription is lost; traces of the lost 16th letters of lines 1 and 2 are still visible; but after *váṭeká* there is no trace of anything further having followed.

1 2 3 4 5 6 7

II, * * वै भू ना नां द या थं * *

* * ि ना

In the first line, the 1st letter is slightly broken; the 5th might be *de;* the 7th is probably the beginning of the word *thaṃbha* 'pillar.' In the second line the first consonant is lost, though the accompanying vowel *i* is distinct; perhaps the word was *káritá* or *pratisthápitá*. Ed.]

Inscription III.[1]

॥ गाम घोसूंडी की बावड़ी की प्रशस्ति ॥

॥ ॐ नमो गणेशाह्री[2] नमः । श्रीवीरस्वत्यै[3] नमः ॥

कमलविमलदलदलिकुलमंजुलसदपांगरोचनं नयनं । गिरिदुहितुर्द्दलयतु मम मानसतिमिराणि करुणया किरणैः ॥ १

स्कंधावधिप्रथितसिंधुरसंनिवेशादाविःकरोति सुरकुंजरतां निजां यः ॥ प्रत्यूहमोहमपहाय वरीभरीतु मन्मानसं सरसवाग्भिरसौ गणेशः ॥ २

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[1] [This inscription has been carefully checked with the help of two good ink impressions, sent by the Kaviráj. The *aksharas* enclosed in brackets are doubtful on the stone, and have been conjecturally restored. Ed.]

[2] Read गणेशाय।

[3] Read श्रीसरस्वत्यै।

खुम्माणक्षोणिपाणाम्वयकमलरवेः[4] कुंभकर्णस्य सूनुर्धर्मात्मा राजमल्लो ऽवनिपतितिलकश्चित्रकूटे चकास्ति । इष्टापूर्तैरनातीकृतकविनिकरोद्गीतसंकीर्त्तिप्रशस्तिर्यो माद्यन्मालवेंद्रप्रबलतमचमूगर्वसर्वस्वहर्त्ता[5] ॥ ३

राष्ट्रवर्यनरनाथमंडलीमौलिमंडनमणिर्मरुस्थली[6] । उद्धृताखिलविपक्षकंटकामाशशास रणमल्लभूपति[7] ॥ ४

एतस्मिन्नमरसदस्यतामवाप्ते तत्सूनु(र्ध)रणिभरं बभार सद्यः । श्रीयोधक्षितिपतिरुग्रः[8] खड्गधारानिर्घातप्रहतपठाणपारसीकः ॥ ५

पूर्वानतारीत[9] गयया विमुक्तया काश्यां सुवर्णैर्विपुलैर्विपश्चितः ॥ वितीर्य कन्याविधिवत्तुतोष यो यो यात्प्रयागे[10] मरुमेदिनीपतिः ॥ ६

किं नाहौषीद् यज्ञभूमौ सुरेभ्यः किं न प्रादा[द्]ानभूमौ द्विजेभ्यः ॥ कं नाजैषीत् संगरे पारसीकं किं नाकार्षीत् योधभूपो यशस्यं ॥ ७

अमुष्यजगतीपतेरजनि कन्यका स्ववंधूविजित्वरगुणोत्करा सुचरितैकविश्रामभूः ॥ यदस्तनुविनिर्मितौ समभवत[11] विधाता कृती ध्रुवं कुसुमसायकः प्रयततेस्म शिल्पे ऽथवा ॥ ८

द्वितीयवयसं लसत्सहचरीवचोभिर्विदन्निमामिति महीपतिः पक्षतिभिः[12] सहाचिंतयन्[13] ॥ गुणानुगुणमेव यो[14] कमपि चेन्महीवल्लभं लभेमहि विदध्महे दुहितृसंप्रदानं तदा ॥ ९

आजलराशि महीतलमहीपतीनाकलय्य निरंटंकि । तैरनुरूपगुणश्रीरेतस्या राजमल्लनरनाथः ॥ १०

अ[त्रां]तरे प्रोढवचोभिरुच्चैर्वंदिव्रजे[15] संस्तुवति क्षितीश्वरम्[16] । श्रीराजमल्लश्रुतिवाग्विलासस्तस्यावरोधे स्फुटमाविरासीत् ॥ ११

अरे धरणिवल्लभा वसुमतीप्रसूनाशुगं स्तुमः समदसुंदरीजनमनःप्रमोदयं[17] ॥ वरिभ्रमतु न विभ्रमं शृणुत मागधव्याहृतं. विराजति न राजके क्वचन राजमल्लोपमः ॥ १२

'अमंदतरसंगारे[18] प्रबलवैरिवीरव्रजात्[19] विजित्य वसुधाविधेरकृतविप्रसाद्धर्म-

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[4] Read ०क्षोणिपालाब्ज० ।

[5] Read ०नार्जीकृत० ।

[6] Read ०स्थलीं ।

[7] Read ०भूपतिः ।

[8] Read उग्रखड्ग०, *metri causa.*

[9] Read ०तारीत् ।

[10] Read ऽयात्प्रयागे ।

[11] Read समभवत् ।

[12] Read प्रकृतिभिः ।

[13] Read अचिंतयत् ।

[14] Read यं ।

[15] Read अत्रांतरे प्रौढ०

[16] Read क्षितीशम् *metri causa.*

[17] Read प्रमोदोदयं ।

[18] Read संगरे ।

[19] Read ०व्रजान् ।

धीः[20] ॥ यशाभरमहीभरद्धरणिमाचतुःसागर[21] गुणैस्तदतिरिच्यते जगति राजमल्लो विभुः ॥ १२

मृगांकमुकुटः स्फुटं वरमयच्छदच्छाशयस्तदंन्वयभुवोभवो[22] भवतु राज्यमित्यम्रतं[23] ॥ ततः सकलमेदिनीरमणमौलिरत्नं जयत्ययं वसुम(तिप)तिर्जगति कुंभकर्णात्मजः ॥ १४

इति मागधस्तुतिवचःप्रतिध्वनिप्रतिबोधहृष्टमनसामियं मतिः ॥ अवरोधवारिजदृशामभूत्परं वृयतामयं[24] नृपतिरेतया द्रुतं ॥ १५

अथ वैवाहमहोपकृतेः[25] कृते कृतमतीन् प्रकृतींस्त्वरय[26] दिशन्। नृपतयः सहजा यदपेक्षितं तदुपनीतममीभिरतर्कितैः ॥ १६

तदनु मरुधराधराधिनाथैर्युवतीरत्नमिमामुपानयद्भिः ॥ सहगजतुरगादिवस्तुजातै[27] सुतरां तोषमलंभि राजमल्लः ॥ १७

शृंगारदेवीत्यभिधां मनोहरं प्रेम्णोपनीतामनुतामभाषत॥ तया समं पुष्पशरोमवेक्षती[28] कलाकलापैः कलयत्यनेहसं ॥ १८

पातिव्रत्यविलासवासनगरी लावण्यलीलागृहं सौभाग्यामृतदीर्घिका वितरणप्रागल्भ्यलीलामरः[29] ॥ सौहित्यं नृपकुंभकर्णतनयं श्रीराजमल्लं वरं संप्राप्याधिकमाविभर्त्ति सततं शृंगारदेवी रहः ॥ १९

वापीमचीखनदियं मणिबद्धभित्तिमम्भोनिधेः सहचरीमिव भूरिनीरां ॥ यामंबुराशिमपहाय रमासमेतः श्रीकेशवः समधितिष्ठति वारिलुब्धः॥ २०

रम्यारघट्टघटितोरुघटीविनिर्यदंभोभिषेकमनुभूय महीरुहो मी[30] ॥ रंभारसालपनसाः पथिकातिथेयश्रेयो दिशंति निजभर्तुरदस्तटीस्थाः ॥ २१

उपर्युपरितत्तटीं विटपिनः सदामोदवत्प्रस्तमभरविभ्रमद्भ्रमरमंजुगुंजायुजः[31] ॥ अनारतमवर्द्धयन्मरुधराधिनाथात्मजा[32] समर्चयितुमङ्गिणामखिलमंघ्रमंप्रदां ॥ २२

शृंगारदेव्या सह राजमल्लः सनीरपूर्णापि च वापिकेयं॥ यावद्धरासागरसूर्यचंद्रं राजंतु सानंदमनंतरायाः ॥ २३

ऋतु-बाण-बाण-शशि-संख्यवत्सरे[33] नभसः सितस्मरतिथौ सभूमिजेः[34]॥ परिपूर्णभावमभजत्सुवापिका सगुणप्रशस्तिरपि सूक्तिशालिनी ॥ २४

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[20] Read वसुधावधेर्

[21] Read यशोभर० ।

[22] Omit the anuswára.

[23] Read राज्यमित्युम्रतं ।

[24] Read व्रियताम् ।

[25] Read विवाह० ।

[26] Read त्वरयादिशन् *metri causa.*

[27] Read वस्तुजातैः ।

[28] Read पुष्पशरासवैक्षती ।

[29] Read ०लीलासरः ।

[30] Read ऽमी ।

[31] Read ०त्प्रसून० ।

[32] Read अनारत० ।

[33] Read संख्यावत्सरे ।

[34] Omit the visarga.

विप्रो दशपुरज्ञातिरभूज्जोटिंगकेशवः। अत्रिस्तस्य सुतस्तस्मान्महेशो भूम्नहाकविः[35] ॥ २५

प्रासाद एकलिंगस्य कीर्त्तिस्तंभस्य चोपरि ॥ अकार्षीद्यो महोशो[36] साविमामप्यकरोत्सुधीः[37] ॥ २६

संवत् १५६१ वर्षे शाके १४२६ प्रवर्त्तमाने उत्तरायनगते[38] श्रीसूर्ये वसंतऋतौ महामांगल्यप्रदवैशाषमासे[39] शुक्लपक्षे तृतीयायां पुण्यतिथौ बुधवासरे यथावर्त्तमान नक्षत्र योगकर....॥

Translation.

Oṃ ! Obeisance to Gaṇeśa and the divine Sarasvatí :

1. May the eyes of Párvatí the beauty of whose glances is as splendid as a whole family of black bees in the act of their pretty gyrations in a lotus, dissipate the darkness of my mind with their rays.

2. May Gaṇeśa who manifests his elephantine rank among the gods, by having the unmistakable shape of an elephant down to the shoulders, remove the ignorance generated by obstacles, and completely inspire my mind with elegant expressions.

3. The pious and excellent king Rájamalla, the son of Kumbhakarṇa, the sun of the lotus-like race of king Khummaṇa, is reigning at Chitrakúṭa, his praise being sung by numerous poets, who were made happy through his meritorious deeds, because he crushed the pride of the mighty army of the haughty prince of Malwa.

4. King Raṇamalla, who was the crest jewel of the noblest princes of the empire, was the ruler of Marusthala, having rooted out from it all its thorn-like enemies.

5. On his gaining the membership of the assembly of the immortals, forthwith his valiant son Yodhá, who had cut off the Paṭhán race of the Persians with the edge of his sword, bore the burden of the land.

6. That lord of the Marumediní (*Abode of sand*), who had the satisfaction of having duly fulfilled the ceremonies of *Kanyá Dána* (giving away girls in marriage) and had undertaken a pilgrimage to Prayága satisfied his forefathers by performing funeral obsequies to their manes at Gayá, and gratified learned men by giving charities in gold at Káśí.

7. What did he not offer in fire on the sacrificial ground to the gods, what did he not give away to the Bráhmans on the charity ground; what Persian did he not defeat in battle, and what deed of fame was not accomplished by king Yodhá!

[35] Read ऽभून्महा० ।

[36] Read महेशो ।

[37] Read ऽसावि० ।

[38] Read उत्तरायणगते ।

[39] Read ०वैशाख० ।

8. Unto such a king was born a daughter, who by the number of her virtues surpasses the wives of the divinities and who is a repository of noble actions. In the finish of her body the skilful Creator has reached the acme of his power, or rather Cupid himself has exhibited his skill in the fine arts.

9. The king perceiving, from the words of her playmates, her childhood to be over, proposed to his ministers to give her away in marriage, when a prince equal to her in virtues could be found.

10. On a searching examination having been made among the kings of the earth as far as the shores of the ocean, king Rájamalla (Rai Mall) was found to be a match for her in virtues.

11. While a host of bards were chanting in high and mighty terms the praises of the king, whispers regarding Rájamalla penetrated the precincts of the (Maṛwaṛ) king's zenáná.

12. O ye princes, listen to the words of the heralds, and raise no doubts: we are praising the terrestrial Cupid, the generator of delight in the hearts of the fair sex in the height of passion: Rájamalla is next to none among the princes.

13. Having gained the victory over a host of brave adversaries in a raging battle, the dutiful (king) offered (the spoils collected) from the ends of the earth to the bráhmans. Rájamalla filled the earth extending to the four oceans with his renown, and now reigns supreme in the world by reason of his noble attributes.

14. The well-meaning S'iva, who bears the moon on the forehead, had openly granted a boon in these terms: 'let prosperity attend thy posterity, and let thy kingdom prosper'; hence Kumbhakarṇa's son, the head-jewel of kings, is triumphant in the world.

15. The queens (lit. the lotus-eyed ones of the harem), being delighted in their hearts with hearing the echoes of the foregoing eulogium of the bards, resolved that this king should be married to that princess at once.

16. The dependant chiefs (of the bride's father) ordered the cleverest officials to make haste in preparations for the wedding festivities, and all the requisite things were readily supplied without an 'if' or a 'but.'

17. Then Rájamalla was fully satisfied with presents of elephants, horses and a store of other articles given him, as dowry by the king of Marwar, along with the princess.

18. He lovingly talks with his affectionate bride who bears the name of S'ṛingára Deví (goddess of adornment); and with her, under the influence of Cupid, he passes his time in many a prank of love.

19. S'ṛingára Deví, the abode of chastity, beauty, prosperity and

charity, having obtained Rájamalla, the son of Kumbhakarṇa, as her consort, perpetually enjoyed intercourse with him to her heart's content.

20. She dug this pond, having sides decked with gems, a rival of the ocean, of unfathomable waters that have tempted Vishṇu to transfer his maritime abode, and take it up here with his spouse Ramá.

21. There are trees there, irrigated with the water raised by means of large pitchers attached to the admirable wheel. The plantain, mango, and panas (*Artocarpus integrifolia*) which grow on its banks, exhibit their owner's excellence in affording hospitality to travellers.

22. Here and there upon its banks there are Banian trees enlivened by the humming of black bees swarming about the bunches of their flowers of perennial fragrance. Unceasingly the daughter of the king of Marudhara added (to their number) with a view to worship Párvatí the bestower of all felicity.

23. May Rájamalla wedded to S'ṛingára Deví, and this pond filled with lucid water, continue to shine as long as the earth, the ocean, the sun, and the moon endure.

24. This pond as well as this inscription of elegant style and containing good lessons, were finished on Tuesday the 13th of the bright half of S'rávaṇa S. 1556 (21st July 1499).

25. There lived a Bráhman of the Daśará caste, Joṭinga Keśava by name; his son Atri had a son Maheśa who was a great poet.

26. The same poet Maheśa who composed the inscription in the temple of Ekalinga and of that on the tower of victory, is likewise the author of this.

Samvat 1561, S'aka 1426, third day of the bright half of the auspicious month of Vaiśákha being Wednesday in the spring season when the sun was in his northern course (19th April 1504).

Notes on the City of Hirát.—*By* Captain C. E. Yate, *Political Officer, Afghán Boundary Commission.*

[The following paper is a revised reprint of portions from Captain Yate's printed report to Government. The inscriptions have been revised by Maulawí Abdul Hak Abid, who has added translations together with some critical and explanatory notes (marked A. H. A.) The inscriptions, however, would require to be verified by collating with the originals or facsimiles. Some of the names are doubtful (marked ?). Ed.]

The most prominent feature of the city is the 'Arg-i-Kuhnah' (?) or old citadel, which stands on the northern face towering over the rest of the city. That this citadel was formerly a place of great strength, is proved by Ibn-i-Ḥauqal, who writes—"Hirát has a castle with ditches. This castle is situated in the centre of the town and is fortified with very strong walls." This building, which is altogether some 250 yards in length, now stands not in the centre of the town, but slightly back from the main northern wall. The ditches mentioned are now mostly choked up and full of reeds, though efforts are being made to clear them out.

The only building noticeable by its size and height above the uniform level of mud houses is the Jám'ih Masjid, a large and lofty structure in the north-east portion of the city. Ibn-i-Ḥauqal says—"In all Khurásán and Máwaráu-n-Nahr there is not any place which has a finer or more capacious mosque than Hirí or Hirát. Next to it we may rank the mosque of Balkh and after that the mosque of Sístán." But there is nothing in the Jám'ih Masjid to record its age that I know of, older than an inscription in the Khaṭ-i-Ṣulṣ character on a slab above the 'Miḥráb', put up apparently by Sulṭán Abú Sa'íd in A. H. 866, to record the abolition of some oppressive tax. This date corresponds with about A. D. 1461, seven years before Abú Sa'íd's death, and at a time when, so history says, he was engaged in waging war with Turkish tribes in Khurásán.

The objects of interest outside the city are almost entirely confined to religious structures such as the Muṣallá and to Ziyárats or shrines. Of the latter the most famous is the shrine of Gázurgáh, a large building up at the foot of the hills some two miles to the north-east of the city, and the residence of the Mír of Gázurgáh, one of the most richly endowed and influential divines in the Hirát district. The office of Mutawallí or superintendent of the religious endowment of this shrine has descended for generations in the family of the present Mír Murtaẓá. The Mír's oldest son Muḥammad 'Umar Ján, a man of some 35 years of age, is married to a daughter of the late Amír Sher 'Alí, a sister of Sardár Ayyúb Khán.

The shrine is distinguishable from afar by its huge, lofty, square-topped building surmounting a high arch, the usual feature of all sacred buildings in this country, and is well worth a visit if only to see the beautiful carved marble headstone surmounting the tomb of the saint and the simple yet handsome tomb of the Amír Dost Muḥammad.

Passing first through a large walled garden of pine and mulberry trees, the visitor comes to an octagonal domed building full of little rooms and three-cornered recesses, two stories in height and all opening inwards, built apparently as a cool, breezy place in which to pass the heat of the summer days. Beyond this again is the main enclosure of the Ziyárat, now a deserted and dilapidated-looking place; everything bears a look of decay; the unkept courtyard, the broken tile work on the archway and entrance to the shrine, and general want of repair everywhere visible, betoken a great falling off from former prosperity.

There is a covered reservoir built, according to local tradition, by a daughter of Sháh Rukh, but the following inscription, which was deciphered with some difficulty, proves that the reservoir was originally built by Sháh Rukh himself, but fell into disrepair and was subsequently restored, 243 years after his death, by some lady of royal descent, whose name, as usual, is not given :—

(1) بر سردر برکه بخط نستعلیق نوشته شده

* بهر تعظیم مزار خواجهٔ انصار کرد *
* خان عادل شاهرخ چون وضع بنیاد جمیل *
* صحن گازرگاه را رشک بقیع الجنه دید *
* از فیوض روح اهل‌الله چون قدس خلیل *
* بقعها انشا نمود و تکیه‌ها ایجاد کرد *
* بهر [1] توحید و ثنای مالک الملک جلیل *
* ساخت بهر. تشنکان زایر این آستان *
* این مصفی برکه‌در راه رضای حق سبیل *
* سالها زین خیر جاری برد خالق الله فیض *
* چون سحاب تشنه آب رحمت از دریای نیل *
* چونکه عمری همچو کشتی سیلی امواج خورد *
* ساخت مستغرق پیش را عاقبت حمل ثقیل *
* نیست در ترکیب آب‌وخاک چون رنگ ثبات *
* باعث ویرانیش را شد کهن سالی دلیل *

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[1] Perhaps تمهید A. H. A.

* کرد تعمیـــرش [1] زاحفادقاآن مرحومهٔ *
* بهر تحصیل ثواب باقي و خیر جزیل *
* مهد علیا عصمت الدنیا در درج حیا *
* آنکه نبود در حریم عفتش شبه و عدیل *
* تاخورد زین برکه یکدم آب هر لب تشنهٔ *
* سازدش شاداب از کوثر خداوند جلیل *
* سال تعمیرش خَضِر جستم زپیر عقل گفت *
*ریخت از بهر کرم در [2] (حوض زمزم سلسبیل) *

This inscription by the Abjad reckoning gives the date of A. H. 1100 or A. D. 1689.

The entrance to the shrine lies at the eastern end of the main courtyard, through a doorway under a high arched vestibule and across a covered corridor, paved with slabs of white marble, worn and polished into the most dangerous state of slipperiness by, presumably, the feet of countless pilgrims. Roundabout this door sit Mullás, beggars and pilgrims of sorts, in addition to the numerous blind Ḥáfiẕ or reciters of the Qurán who here seem to act as the general showmen of the place.

Immediately in front of the entrance and looking inwards, but now half-buried in the ground, is the carved figure in white marble of a long, thin animal, said to be a tiger, though what a tiger is the symbol of in such a place I cannot say.

Passing through the entrance one emerges into a square courtyard surrounded by high walls and little rooms, with a lofty half-domed portico at the eastern end, the tile work on which is very much out of repair. It is generally the custom to engrave the date of any mausoleum over the entrance door, but there is no date engraved on this.

On either side of the entrance are the usual retiring rooms with arched prayer niches. In the northern niche the following text is engraved:—

(2) فنا دتهٔ الملائکةُ و هو قائمٌ یصلّي فی المحراب

---

[1] The word قاآن is doubtful here. The line does not scan and may be changed thus:—* کرد تعمیرش یکي ز احفاد خان مرحومهٔ * A. H. A.

[2] [The numerical words are enclosed within brackets; thus ح = 8, و = 6 ض = 800, ز =7, م =40, س =60, ل =30, ب =2, ی =10; hence 8+6+800+7+40+7+40+60+30+60+2+10+30=1100. Ed.]

The tomb of the saint Abú Ismá'íl Khája 'Abdu-lláh Anṣárí is a large mound, some 10 yards long by 6 feet high, covered with stones, and stands immediately in front of the arched portico under the shade of a tree.

The tradition is that the original buildings having fallen into decay, the present structure was erected by Sháh Rukh Mírzá, the youngest son of Amír Tímúr, who ruled at Hirát from A. D. 1408 to 1446.

The great feature of the shrine is the headstone of white marble to the grave of the saint, which stands some 14 or 15 feet in height and is most exquisitely carved throughout. This stone is a beautiful piece of work, as not only is the carving of texts and inscription well executed, but the whole proportions of the stone are beautiful. The whole of the Arabic inscription, carved in what is known as the 'Khaṭ-i-Ṣuls' character, could not be deciphered, but at the end of it the name of the saint is entered in full, Abú Isma'íl Khája 'Abdu-lláh Anṣárí, and the date A. H. 859 also appears. This date, though, corresponds to about A. D. 1455, or 9 years after the death of Sháh Rukh, and owing to the whole of the inscription not having been deciphered, it is uncertain what it refers to.

The date of the death of the saint, recorded in the following quartrain, seems to have been subsequently inscribed, as it appears on a separate corner of the stone and in a different character :—

(3) * آن خواجه که در صورت و معني شاهست *
* وز[1] سر حقيقت دو كون آگاهست *
* از روی حساب جمل ارداني (فات) *
* تاريخ وفات خواجه عبدالله است *

"Fát" by the Abjad reckoning equals A. H. 481, or about the year A. D. 1089.

On one side of the tomb the following inscription appears, recorded by Ḥasan, son of Ḥusain Shámlú, in the year A. H. 1094 or A. D. 1640 :—

(4) * دهد تا ساقي عرفان دامت وا جام هشياري *
* در آدر بزمگاه خواجه عبدالله انصاري *
* بود لوح مزارش نازنين سروي كه از شوخي *
* ملايك را چو قمري كرده گرم ناله و زاري *

---

[1] Read از A. H. A.

Round the tomb itself the following inscription appears :—

(5) * طُوبى لِرَوْضَةٍ سَجَدَتْ أَرْضُهَا الْجِبَاه *
* بُشْرى لِسُدَّةٍ لَثَمَتْ تُرْبَهَا الشِّفَاه *
* این آستانه ایست که از خاك او برند *
* شاهان ملک افسر عزو سریر جاه *
* رخ چون نهد بسدهٔ والایش آفتاب *
* چرخ ارنه زیر پاش .نهد قامت دوتا *
* چون ابر اگر ز سقف رواقش چکد مطر *
* سر بر زند ز طارم چرخ برین گیاه *
* گیرد جهان ز شمسهٔ ایوان او فروغ *
* بر صدق این سخن دو گواهند مهر و ماه *
* بندد بروی خود همه درهای حادثه *
* هرکس که آورد بحریم درش پناه *
* این منقبت ز دولت صاحبدلي گرفت *
* کز مهد خاک کرده در این بقعه جایگاه *
* پیر هرات زبدهٔ انصاریان که سود *
* بر طاق چرخ قبهٔ دهلیز او کلاه *
* تصنیف اوست درس مقیمان مدرسه *
* تلقین اوست ذکر مریدان خانقاه *
* کازر گهست تربت او کابر مغفرت *
* در ساحتش سفید کند نامهٔ سیاه *
* میل سر مزار پر انوار او کشد *
* زوار را بدیدهٔ دل کحل انتباه *
* دلو زریست صورت قندیل مرقدش *
* کز وی رهیده یوسف دلها ز حبس چاه *
* نور ولایتش که جهان را فرو گرفت

* تا حشر بادهادي آفتادگی راه *
* جامي حريم كعبهٔ هر حاجت اين دراست *
* روی دعا بكعبه كن و حاجتی بخواه *

The Amír Dost Muḥammad's tombstone is a plain simple but handsome block of pure white marble, some 8 feet in length by about 1½ or 2 feet in height and breadth, finely carved and surrounded by a marble balustrade. It lies just to the north of the saint's tomb in the open enclosure. At the head and foot of the grave stand small blocks of white marble, carved in imitation, but a very bad imitation, of the head and foot stones of the Kh̲ája's tomb. They are dwarfed and quite lost in comparison with the original monuments.

The Amír Dost Muḥammad Kh̲án died in 1863, a few days only after the capture of Hirát, and curiously enough there lies buried quite close to him his rebellious nephew Sulṭán Aḥmad Kh̲án, the son of Muḥammad 'Az̤ím Kh̲án, brother of Dost Muḥammad, the then ruler of Hirát, whom he was besieging and who died during the siege in the spring of the same year.

The remainder of the enclosure is as full of graves as it can hold, not only of notable Afg̲h̲áns, but of members of the Ṣafwian dynasty and also of the descendants of Jingíz Kh̲án, the latter apparently predominating.

Inside the portico also there are some 20 or 30 tombs mostly of the families of Jingíz Kh̲án and Sháh Rukh̲. One of the tombs of some member of the latter's family is noticeable by the fine block of black marble of which it is composed, beautifully carved and inscribed in Arabic. It bears the date of A. H. 895 or about A. D. 1490. Another to Rustam Muḥammad Kh̲án, a descendant of Jingíz Kh̲án, bears the date, according to the Abjad reckoning of the following Persian verses inscribed in the Nast'alíq character, of A. H. 1053 or A. D. 1643 :—

(6) * فروغ كوكب چنگيز خان آرايش مسند *
* بنا كامي قدم بيرون نهاد از عرصهٔ دوران *
* عزيز مصر دولت آفتاب مشتري شوكت *
* بهار بوستان سلطنت رستم محمد خان *
* برون آمد يكي از غيب گفته سال تاريخس *
* (بود در ملک عقبی پادشاه مسند ايمان) *

Another marble tombstone has an Arabic inscription in the Ṣuls̤ character, recording the death of Muḥammad.'Iwaẓ Khán, simply described as the son of the third Khán in A. H. 1057 or A: D. 1657.

A marble tomb to Muḥammad Amín Khán, another descendant of Jingíz Khán, is dated, according to the Abjad reckoning of the following line, A. H. 1076 or A. D. 1666 :—

(7) مادهٔ تاریخ محمد امین خان (روضهٔ جاودان) است

Another marble tomb to Sháhzáda Masa'úd is dated, according to the Abjad reckoning of the following verses, A. H. 1256 or A. D. 1840 :—

(8) * افسوس که دوران فلک کوکبي افکند *
* کز برج شرف تافتی از طالع مسعود *
* انداخت سهي سروی از روضهٔ شاهي *
* کز نالهٔ قمري شنوي سوز غم آلود *
* زاهفاد شهي کز شرف کعبهٔ اسلام *
* فیروزي دین عاقبتش ساخته محمود *
* شهزادهٔ مسعود که با پر ذلي وجود *
* میداشت بعادت ادب و پر دلي وجود *
* تاریخ وفاتس چو خرد خواست ز رضوان *
* گفتا (به بهشت آمده شهزادهٔ مسعود) *

Several other marble tombs have had the names and dates obliterated, and one of black marble, finely engraved in Arabic, bears no name but the date of A. H. 865 or A. D. 1461.

In the rooms around the enclosure there are many notable tombstones. One of the finest of these is to the mother of some monarch, known as the "Mahd-i-'ulyá," but the tombstone has no other name on it or anything to show who she was, as it was apparently the custom at the time of her death not to inscribe a woman's name on her tomb. The date of her death is fixed by the following hemistich :—

(9) مهبدت انوار عفو از لطف بیچون ابد

literally, "the place of descent of the light of pardon from the kindness of the Incomparable and Eternal God." It would appear that Mahbit̤ has been purposely incorrectly spelt, having been inscribed Mahbit instead of Mahbit̤ for the sake of the date. As it stands the date is A. H. 866 (A. D. 1462) corresponding more with the rest of the tombs. Otherwise the date would be A. H. 475 (A. D. 1083), apparently considerably anterior to any of the others.

A marble tomb to Ustád Muḥammad K̲h̲ája is dated in Arabic A. H. 842 or A. D. 1439. Another to K̲h̲ája Sulṭán Muḥammad, dated in Arabic A. H. 761 or A. D. 1360, was the oldest tomb noted.

Another tomb of some Sháh Ruk̲h̲ K̲h̲án, made of marble and engraved in K̲h̲aṭ-i-Nasta'líq, has the following couplet:—

(10) * گل گلزار خوبي شاهرخ خان *
* که رفت از این جهان با نور ایمان *

which gives the date by the Abjad as A. H. 1168 or A. D. 1755.

Another to Muḥammad Raḥím K̲h̲án, bears the following inscription:—

(11) ببود گفت محمد رحیم خان ایمان

giving a date of A. H. 1201 (A. D. 1787).

A black marble tomb finely engraved in the K̲h̲aṭ-i-Ṣulṣ to the daughter of some king, name illegible, bears the date A. H. 1109 or A. D. 1698 in the following line:—

(12) بود معصومهٔ احفاد خاقان

A marble tomb to Muḥammad Qulí Sulṭán has the following engraved in the K̲h̲aṭ-i-Nast'alíq:—

(13) سال تاریخ او ریاض جنان

giving the date of A. H. 1015 or A. D. 1607.

A tomb of some one "Az aulád-i-Saláṭín," but name illegible, has the date A. H. 893 A. D. 1488, engraved in Arabic:—

(14) ثَلَاثٍ وَتِسعِينَ وَثَمَانِمائَةٍ

There is a handsome black marble tomb finely engraved in the K̲h̲aṭ-i-Ṣulṣ character to Sulṭán Muḥammad Báyasung̲h̲ur Ibn-i-Sháh Ruk̲h̲ Ibn-i-Tímúr, but it has had the date carefully erased.

Another tomb of some ruler has the name illegible, but the couplet:—

(15) * بهر تاریخ شه عالیقدر *

* طَيَّبَ اللهُ تَعَالٰی مَثْوَاهُ *

gives the date of A. H. 1115 or A. D. 1704.

Another black marble tomb, name unknown, bears the date of A. H. 902 (A. D. 1487) in the following couplet:—

(16) * برسر تربت او کلک قضا *
* کرد تحریر فَقَدْ طَابَ ثَرَاهُ *

There was formerly a Qadamgáh, or stone bearing the mark of the footstep of Ḥaẓrat 'Alí, in an arched portico built by Sháh Ṭahmásp Ṣafawí on the north side of the court. The stone apparently was carried away, as shown by the following words at the end of the inscription over the arch:—

(17) که بودی قدمگاه شاه ولایت

which gives the date, by the Abjad reckoning, of A. H. 949 or A. D. 1543.

On the south side of the court the corresponding portico has fallen down and the tombs in it are buried under the debris. At the door on the right-hand side as one enters the inner court is a large circular font of white marble, used though, so far as I could learn, only as a bowl to mix sherbet in for the use of the pilgrims visiting the shrine.

Between the Gázurgáh and the Joe Náo or new canal is the tombstone of Amír Jalálu-d-dín, dated A. H. 858 or A. D. 1454, but the name of his father is obliterated. Jalálu-d-dín himself is named the Shahíd, proving that he met a violent death.

Of the other shrines around Hirát, the largest is the Ziyárat-i-Awal Walí as it is commonly pronounced, but in reality the tomb of Sulṭán Abú-l-Walíd Aḥmad, the son of Abú-r-Raẓá 'Abdu-lláh Ḥanafí of Azádán of Hirát, who died in the year A. H. 232, or about A. D. 847.

The tombstone over the grave has disappeared, but the following inscription taken from a slab, put up over the door of the shrine by Sulṭán Ḥusain Mírzá, gives the name and date of the death of the saint, though the date of the inscription on the slab is not mentioned.

(18) اَبُو الْغَازِي مُعِزُّ الْمُلْكِ وَ الدِّينِ شاه سُلْطَانُ حُسَيْنُ اَبُوالْوَلِيدِ اَحْمَدُ بن
اَبِي الرِّضَا عَبْدِاللهِ الْحَنَفِيِّ الازاذي وَقَعَتْ وَاقِعَتُهُ سَنَةَ اِثْنَيْنِ وَ ثَلَاثِينَ
وَ مِائَتَيْنِ

The shrine lies some two miles to the west of the city, and the present building was, it is said, erected by Sháh Sulṭán Ḥusain, who reigned at Hirát from A. D. 1487 to 1506. It possesses the usual lofty arched portico with a domed enclosure containing the tomb behind and other rooms around, but is built of plain brick throughout and unadorned except by some mosaic work inside. The garden in front has been allowed to fall into decay, but some lofty pine-trees still remain.

There is another large and similar shrine about a couple of hundred yards to the south of the city, known as the Ziyárat-i-Sulṭán Mír Shahíd. The tomb stands in the centre of the lofty domed enclosure immediately behind the arched portico, and is surmounted by flags of many colours, the poles of which are mostly topped with the figure of an open hand. No meaning appears to be attached to the symbol; it is simply said that the standards, presented by the Prophet to his people, were surmounted by a hand, and the tradition still remains.

To show how little is known about the history of these shrines, I may mention that I was assured that the saint buried here was Sulṭán Mír 'Abdu-l-Wáḥid, the ruler of Hirát, when the city was besieged and captured by Hulákú Khán, the son of Túlí Khán, son of Jingíz Khán, shortly after his capture of Baghdád in A. D. 1253, and that Sulṭán Mír 'Abdu-l-Wáḥid fell in the defence and thus earned the title of Shahíd or martyr. On having the tombstone cleaned from the lamp oil and dirt of ages, it appeared, however, from the Arabic inscription, that the name of the saint was 'Abdu-lláhu-l-Wáḥid, the son of Zaid, son of Ḥasan, son of 'Alí (the son-in-law of the Prophet), son of Abú Ṭálib; that he was born either in A. H. 35 or 37 (A. D. 656-58), and that he died in A. H. 88 (A. D. 707) in the lifetime of his father; that his grave was found in A. H. 320 (A. D. 932) in the time of 'Alí, son of Ḥasan (an Imám of the Zaidí sect) and of Shaikh Ḥasanu-l-Baṣrah, and that the present shrine was erected by Sháh Sulṭán Ḥusain in A. H. 890 or A. D. 1486.

In the same building there is another tomb. The inscription on the stone gives the name Ja'far Abú Isḥáq and date A. H. 289 or A. D. 902.

In addition to the Ziyárats at the city gates, there is a small shrine called the Ziyárat-i-Khája 'Alí Baqar on the north-east side of the city, and another called the Ziyárat-i-Khája Táq (?) adjoining a graveyard, used as the burial-place for the Kábulís, a little to the east of the city.

To the north of the city there is a long mound which evidently at some time or other formed part of the rampart of the city wall. This is confirmed by Ibn-i-Ḥauqal, as above quoted, and it is clear therefore that the city extended up to this point as late as the 10th century. This mound is now known by the name of Tall-i-Bangiyán or the mound of the bhang-eaters; the people given to bhang having, it is said, been in the habit of holding their meetings on this mound; before that, the mound is said to have been called Tall-i-Quṯbiyán or the mound of the holy men, from the numbers who lie buried in it. The mound at the present day is one mass of graves, and at one place on the northern side, in digging out the foundations for the fortifications, a large stone-lined mausoleum was found at a considerable depth, full of human bones, but with nothing in it to show who the people buried there were, though they are believed to have been Muhammadans.

There are two shrines on the mound, ordinary domed buildings of burnt brick. One contains the tomb of 'Abdu-lláh, son of Mu'áwiyah, son of Ja'far, son of Abú Ṯálib (the father of Ḥaẕrat 'Alí) and grandson of Zainab (the daughter of the Prophet by his wife Fáṯimah). The following inscription, giving these particulars, is engraved round the pedestal of the tomb, but does not give the date of death; it records the fact that the present building was erected by Shaikh Báyazíd, son of 'Alí Mushrif in A. H. 865 (A. D. 1461).

(19) وَ هُوَ سُلْطَانُ السَّادَاتِ وَ النَّقَبَاءِ - الشَّهِيدُ الْمَظْلُومُ الْمَقْتُولُ غَوَّاصُ لُجَجِ
الْحَقِيقَةِ وَ سَيَّارُ طُرُقِ الشَّرِيعَةِ وَ الطَّرِيقَةِ الْمُخْتَصُّ بِمُشَاهَدَةِ اَسْرَارِ اللّٰهِ الْغَالِبِ
عَبْدُ اللّٰهِ بْنِ مُعَاوِيَةَ بْنِ جَعْفَرِ بْنِ اَبِي طَالِبٍ - رِضْوَانُ اللّٰهِ عَلَيْهِ وَ عَلَى جَدَّتِهِ
زَيْنَبَ الْعَابِدَةِ بِنْتِ الْبَتُولِ ابْنَةِ الرَّسُولِ فَاطِمَةَ الزَّهْرَاءِ بِسَعْيِ الْخَادِمِ الْعَاصِي
الضَّعِيفِ خَادِمِ آلِ عَبَا الْفَقِيرِ الشَّيْخِ بَايَزِيدَ بْنِ عَلِيٍّ الْمُشْرِفِ فِي شُهُورِ سَنَةِ
خَمْسٍ وَ سِتِّينَ وَ ثَمَانَمِائَةٍ .

In the same building there is a tomb said to be that of Mír Ḥusainí, but on the tombstone the name of Amír Muḥammad and date A. H. 838 (A. D. 1435) are inscribed. This tombstone is said to have been brought from elsewhere and stuck up here.

The second shrine is known as the Ziyárat-i-Sháhzada Qásim, but the tombstones here also are said to have been brought from elsewhere. On the headstone to the grave the name of Abú-l-Qásim, son of Ja'far, is engraved in Persian and the date of death A. H. 994 or A. D. 1586, while on the back of the same stone another inscription gives the date of A. H. 897 or A. D. 1492. On the footstone the name of Amír Jalálu-d-dín is engraved, but without date or particulars.

I now come to the Musallá, formerly, I suppose, the grandest building anywhere in this part of the world, but now in ruins and under orders from the Amír 'Abdu-r-Raḥman in course of demolition. The so-called Musallá in reality consists of the remains of three separate buildings, running north-east and south-west, and covering a total space of nearly 600 yards from end to end.

Of the Madrasah or college nothing but two high arches and four minarets remain. The arches must be at least some 60 feet in height and are covered with the remains of fine tile work of beautiful and artistic designs. The tile work on the minarets seems to have been mostly worn off by stress of weather, while inside the arches the tiles in some places are still perfect. The minarets of the Madrasah appear taller than those of the Musallá and must be between 120 and 150 feet in height. There is a tradition that the present remains formed portions of two colleges, known in Turkí as the Kosh Madrasah or pair of colleges, which are said to have been built by Sháh Rukh Mírzá. At the western end of the ruins there is a large, handsome black marble tomb with a well-carved inscription in Arabic, bearing the date A. H. 843 or A. D. 1440. The inscription is broken and covered with dirt, but the following was deciphered, showing that it is the tomb of Báyaqrá, son of 'Umar Shaikh, the son of Amír Tímúr :—

(20) مُعِزُّ الدَّوْلَةِ و الْمُلْكِ وَ الدِّين بايقرا ابنِ السُّلْطَانِ الشَّوِيدِ السَّعِيد عُمَرَ شَيْخ ابن تَيْمُور كوركَان تُوُفِّي في سَنَةَ ثَلَاث و اَربعين وَ ثَمَانمائة ،

The domed building called the tomb of Sháh Rukh stands between the Madrasah and the Musallá. It is faced on the east by an archway and by one solitary minaret, still covered with tile work. The dome, too, was once covered with blue tiles, but is now sadly out of repair.

Within the dome there are six tombstones lying scattered about, all of black marble, engraved in Arabic in the Khaṭ-i-Ṣuls character. The principal of these and the one that gives the name to the building, though the latest in date, is the tombstone of Sháh Rukh, but instead of marking the tomb of the great Sháh Rukh, the son of the Amír Tímúr, and the founder of the Madrasah as I was given to understand, it appears from the following inscription that it is the tomb of some other Sháh Rukh, a great-great-grandson of the Amír Tímúr, who died 47 years after the death of the real Sháh Rukh.

The inscription is as follows :—

(21) مَنْ كَانَ تَقِفُ دُونَ عَيْنَيْهِ مُلُوكُ مَمَالِك الْاِسْلَامِ صَدَفُ الْخِلَافَة

الخانية الشاه في [1]جنه الآفاق ثمرة شجرة الايالة و العدالة بالارث و الاستحقاق
معين السلطنة و الدنيا و الدين شاهرخ سلطان ابن السلطان السعيد سلطان
ابي سعيد كوركان ابن سلطان الاعظم سلطان محمد بن سلطان الاعظم الاعدل
ميرانشاه ابن السلطان الاعظم الاقدم قطب الحق و السلطنة و الدنيا و الدين
امير تيمور كوركان قد وقعت واقعته في خامس عشر من شوال سنة ثمان
و تسعين و ثمانمائة ،

Sháh Rukh Sulṭán, son of Sulṭán Abú Sa'íd, son of Sulṭán Muḥammad, son of Mírán Sháh, son of Amír Tímúr, dated A. H. 898 or A. D. 1493.

The second is the tomb of Báyasunghur, son of Sháh Rukh, son of Tímúr, and is dated A. H. 836 or A. D. 1433 :—

(22) معين السلطنة و الدنيا و الدين بايسنغر ابن شاهرخ ابن تيمور السادس
من شهر جمادي الاولى سنة ست و ثلاثين و ثمانمائة ؛

The third is the tomb of Sulṭán Aḥmad, son of 'Abdu-l-Laṭíf, son of Sulṭán 'Ubaid, son of Sháh Rukh, dated A. H. 848, (A. D. 1445) :—

(23) نظام الدين سلطان احمد ابن عبداللطيف ابن سلطان عبيد كوركان
بن شاهرخ سلطان وقعت واقعته في عاشر ذى الحجة سنة ثمان و اربعين
و ثمانمائة ،

The fourth is the tomb of 'Aláu-d-Daulah, son of Báyasunghur, son of Sháh Rukh, dated A. H. 863 or A. D. 1459 :—

(24) سلطان علاءالدولة ابن غياث الدولة والدين بايسنغر ابن الخاقان السعيد
الحميد معين السلطنة والدنيا والدين شاهرخ سلطان انارالله براهينهم وقعت
الواقعة في سادس ذي الحجة الحرام سنة ثلاث و ستين و ثمانمائة ،

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[1] Read جُمّلة A. H. A.

The fifth is the tomb of Ibráhím Sultán, son of 'Aláu-d-Daulah, son of Báyasunghur, son of Sháh Rukh, son of Amír Tímúr, who apparently died in the same year as his father, *viz.*, A. H. 863 (A. D. 1459) :—

(25) ابراهيم سلطان ابن علاء الدولة ابن با يسنغر ابن شاهرخ ابن اميرتيمور
وقعت الواقعة في يوم الخميس ثامن عشر رمضان المبارک سنة ثلاث
و ستين و ثمانمائة ،

The sixth is the tomb of Gohar Shád, said to have been the wife of Sháh Rukh and the sister of Qará Yúsuf Turkmán and the founder of the Gohar Shád Masjid in Mashhad. The inscription, which is as follows, gives the date of her death as A. H. 861 or A. D. 1457 :—

(26) هذا مشهد من و فقها الله تعالى للجمع بين سلطنة الدنيا و سعادة
الآخرة و بقي على وجه الارض من همتها العالية في طرق الخير اثار عظيمة
باهرة و هي المهد العليا و الستر العظمى بلقيس الزمان مالک الملکات في
بلاد الايمان عصمة الدنيا و الدين كوهرشاداغا انار الله برهانها وقعت تلک
الواقعة العظيمة في منتصف رمضان المبارك من شهور سنة احدى و ستين
و ثمانمائة اللهم اغفرلها ،

There is also a domed building, called after her name, in Kuhsan(?), but it contains nothing to show how it came to be so called.

The Musallá was a huge, massive building of burnt brick and mortar throughout, almost entirely faced with beautiful tile, or rather mosaic work as the various patterns were all formed of small pieces of enamelled tile compactly fitted together in fine gypsum-plaster.

Musallá means the place of prayer, and the building is said to have been erected by Sultán Husain Mírzá (the grandson, I believe, of the Báyaqrá, the grandson of Amír Tímúr, who lies buried in the Madrasah), who ruled at Hirát according to history from A. D. 1487 to 1506. Sultán Husain Mírzá is said to have been buried in the Musallá; but now that the building is in course of demolition, any graves that may be there are buried many feet deep in the debris, and it is impossible to verify the statement.

The main building of the Musallá consisted of a fine, lofty dome some 75 feet in diameter, with a smaller domed building behind it and many rooms around.

The entrance to this was from the east through a lofty archway some 80 feet in height, the outer face of which was one great sheet of mosaic work, mingled with large inscriptions in gilt. Above the archway was a square-topped mass of masonry containing rooms and passages of sorts, adding greatly to the height of the building. Beyond again, or to the east of this archway, was an enclosed courtyard some 60 to 80 yards square, surrounded with corridors and rooms several stories in height, all faced with enamelled tile and mosaic work.

The main entrance to the building lay through another massive archway, also some 80 feet in height; but though the inside of the arch was lined with tile work, the outside was bare and looked as if it had never been finished. Four minarets, some 120 feet in height, form the four corners of the building, and are still for the most part covered with tiles, though a good deal has been worn off by the weather, especially on the north by east, the side of the prevailing wind.

The rooms around the courtyard are supposed to have been for the accommodation of students, who, doubtless, flocked to Hirát in the palmy days of Sháh Rukh and Sulṭán Ḥusain Mírzá.

Beyond the Musallá, a mile or more to the north of the city, there is an old domed building, covered with the remains of tile work, and with a hole in the centre of the floor giving access apparently to some underground chamber now mostly filled up. Local tradition declares that there used to be a passage from this chamber right into the citadel, but the appearance of the building would seem to show that it was built as a mausoleum, though no tombstones are visible.

Some 40 or 50 yards off there are five or six tombstones lying about, both of white and black marble, some inscribed in Arabic and others in the Nast'alíq character, but only one of them could be deciphered, and that was to Amír Jalálu-d-dín and dated A. H. 847 or A. D. 1444.

There is also a stone bearing Amír Jalálu-d-dín's name in the Ziyárat-i-Sháhzáda Qásim, and the third between Gázurgáh and the canal, but who these Jalálu-d-díns were could not be ascertained.

To the west of the domed building with the underground chamber, there are various other shrines and tombs of holy men, so holy that access to them by Shi'ahs even is forbidden by their Sunní guardians. One of these tombs is said to be that of Mauláná Jámí Sha'ir, but the inscription in the Nast'alíq character on a pillar at the head of the grave gives the name of Shaikh Zainu-d-dín, and I mention it because the determination of the date of his death, as rendered by the Abjad reckoning of the inscription thereon, has proved such a puzzle that no two of the experts to whom I have shown it could agree in the interpretation of it.

The inscription is below, and the translation is something to the following effect:—"Shaikh Zainu-d-dín, Imám and leader of men of religion, the axis of the world, the threshold of forgiveness, the relation of truth, who rose from the earth below to the heaven above and on whose skirt there was no dust. His age was 81 and the time of his death was also that number with one year added to the calculation." This inscription has been variously interpreted to me as A. H. 202, 621, 741 and 832 or A. D. 818, 1222, 1341 and 1429; but which is correct I cannot say.

* (27) شیخ زین الدّین امام و مُقتدای اهل دین *
* قُطب گردُون آستان غوث حقایق انتساب *
* از حضیض خاک شد بر اوج علوي و نبود *
* گرد بر دامانش از یالیتنی کُنْتُ تُراب *
* عمر او هشتاد و یک سال و زمان فوت نیز *
* خود همان سازند گر یک سال افزون در حساب *

Translations of the preceding inscriptions prepared by Maulawí Abdul Hak Abid, Professor of Persian, Calcutta Madrasah.

No. 1.

When the just monarch Sháh Rukh laid the foundation of an elegant building for the purpose of doing honour to the sepulchre of the master of the Ansár,[1] he found the open yard of Gázur-gáh,[2] like Quds-i-Khalíl,[3] an object of jealousy to Baqí'u-l-Jannah,[4] owing to the blessings of the souls of godly men.

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[1] Anṣár—assistants, defenders, applied particularly to the citizens of Madínah who assisted Muḥammad when obliged to fly from Makkah (Mecca); also, applied to the descendants of those citizens who now form a tribe called Anṣár. Here the word is used in the latter sense.

[2] Gázur-gáh—name of a place in Hirát, containing the remains of Khája 'Abdu-lláh Anṣárí.

[3] Quds-i-Khalíl—name of a place in Jerusalem containing the tombs of several religious persons, of whom the most famous was Imám Muḥammad Táj-i-Faqíh, whose descendant Makhdúm Sharafu-d-dín Aḥmad lived at Bihár.

[4] Baqí'u-l-Jannah—commonly called Jannatu-l-Baqí' is the name of a place at Madínah, where are buried Imám Ḥasan, Zainu-l-'Ábidín and some other members of their family.

(Here) he built monasteries and erected convents for offering praises and thanks to the Great Lord of the universe.

This clear reservoir he constructed for the thirsty pilgrims of this threshold, for the sake of God's pleasure.

For years men derived benefit from this lasting work of utility, just as a thirsty cloud receives water of blessings from the river Nile.

Because, like a boat for a long period, it received slaps of waves, it was at last made to sink down by the heavy burden (or, its base, at last, sunk down under the superincumbent mass).

As there is no constancy in the material objects, long age proved to be the cause of its ruin.

One of the descendants of the monarch, a deceased lady, repaired it, in order to gain a perpetual reward and numerous blessings.

(She is) the exalted cradle, the chastity of the world, the pearl of the casket of modesty, of whom there is no equal or like in the seraglio of her chastity.

So long as each thirsty one drinks water once out of the reservoir, may the Great God quench her thirst with the water of *Kausar*, (one of the four springs of Paradise).

O Khaẓir ![1] when I enquired of my experienced intellect about the year of its repairs, it suggested (as follows):

" She has poured down for charity's sake the water of the Salsabíl (one of the springs of Heaven) into the reservoir of the *Zamzam* " (the well-known well of Mecca).

No. 2.

" And the angels called to him, while he stood praying in the arched niche." (This is a text from the Qurán, appertaining to Zachariya.)

No. 3.

That Khája, who is both externally and internally a king, is aware of the secret of the real state of both worlds.

If you know, according to the Abjad reckoning, *Fát* is the year of the death of Khája 'Abdu-lláh.

No. 4.

In order that the cup-bearer of the divine knowledge may give your heart the liquor of wakefulness, come to the assembly of Khája 'Abdu-lláh Anṣárí.

The tombstone of his sepulchre is a beautiful cypress which, by its excessive beauty, has so moved the angels that they exclaim and cry like turtle-doves.

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[1] Khaẓir—(case address) - poetical name of the writer.

No. 5.

Welcome to the shrine, on the ground of which bows down many a head! Hail to the threshold, the dust of which is kissed by many lips!

This is a threshold, by the dust of which kings of the world hold the crown of honour and the throne of dignity.

How can the sun put his face on this exalted threshold, if the sky do not double itself under his feet.

If rain shower down from the roof of its lofty building as if from a cloud, grass will grow on the dome of the high sky.

The world receives light from the sky-lights of its building; and of the truth of this saying both the sun and the moon are witnesses. He shuts the doors against all misfortunes, who takes shelter within the compound of its threshold.

It acquired this distinction through the favour of that pious man who took his seat here in the cradle of dust, the saint of Hirát, the chosen of the Anṣár, the dome of whose threshold touched the arch of the sky.

The studies of the students of colleges are his works, and the prayers of the disciples of Kh̲ánaqáhs are his teachings.

His tomb is a gázurgáh[1] (a washing-place), wherein the cloud of the divine forgiveness washes white the black (sinful) records of men.

The Míl[2] (head-stone) at the head of his grave, overcovered with light, serves to apply the collyrium of wakefulness to the eye of the heart of the visitors.

The lantern of his tomb is a bucket of gold in appearance, by means of which the Joseph[3] of the heart got rid of the confinement of the well.

May the light of his saintliness, which has spread over the world, be a guide, up to the day of resurrection, to the travellers led astray from the right path. O Jámí![4] this door is the *Ka'abah,* (sanctuary) for the realization of every desire; so direct the face of supplication to it and submit your want.

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[1] Here the word 'gázur-gáh' is used in its literal sense, as a common noun, meaning a 'washing-place'; but at the same time it refers to the place of that name, mentioned in Note 2.

[2] Míl—a block of stone of roller-like form erected perpendicularly at the head (and sometimes both at the head and foot) of a grave to mark the spot; also, a skewer or wire used to anoint the eye with collyrium. Hence a play upon the word.

[3] Here is a reference to the story of Joseph, son of Jacob, who was thrown into a well by his envious brothers, but an Arabian merchant, Málik, passing by the well, took him out by means of a bucket.

[4] Jámí—poetical name of a celebrated Persian poet, who flourished at Jám (name of a town).

No. 6.

The light of the star[1] of Jingíz Khán, the decoration of the masnad (throne or cushion) has unfortunately put his feet out of the field of the world,

The 'Azíz[2] (king) of the Miṣr (metropolis) of wealth, the sun having the grandeur of Jupiter, the beauty of the garden of royalty, (namely) Rustam Muḥammad Khán.

Some one came forward from secrecy, and dictated the year of his death (as follows):—

"He is the king of the throne (or cushion) of faith in the dominion of the next world."

No. 7.

The words which contain the date of Muḥammad Amín Khán's (death) are '*Rauẓat-i-Jáwidán*' (an eternal garden).

No. 8.

Alas! the revolution of the sky threw aside the star which was shining in the Zodiac of greatness by its happy rise.

It uprooted a straight cypress from the garden of kingship, for in the cry of the dove you hear a mournful groaning.

One of the descendants of the royal family, whose end has become happy on account of the prosperity of the faith, through the holiness of the *Ka'abah* of Islám,

Prince Masa'úd, who, on account of his generosity and spirit, was accustomed to show politeness, high-mindedness and generosity.

When wisdom asked the date of his death from Riẓwán,[3] he replied:—

"The prince Masa'úd came to Paradise."

No. 9.

It is, by the favour of the incomparable Eternal Being, the descending place of the lights of forgiveness.

No. 10.

The flower of the garden of beauty, Sháh Rukh, who went out of this world with the light of faith.

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[1] The word *kaukab* generally means a star; but it may be taken as a contraction of *kaukabah* which is applied to a polished steel ball suspended from a long pole and carried as an ensign before the king.

[2] 'Azíz-i-Miṣr—was formerly the title of the minister of Egypt, but afterwards it was assumed by the kings themselves. Miṣr—*lit.* a large town, applied both to Egypt and its metropolis Cairo.

[3] Rizwán—the porter or gardener of Paradise.

No. 11.

He said "Muḥammad Rahím Khán carried faith with him."

No. 12.

She is a chaste girl of the descendants of *Kháqán* (monarch).

No. 13.

The year of his death is "*Riyáẓ-i-Jinán*" (the garden of Heaven).

No. 14.

Eight hundred and ninety-three.

No. 15.

For the date of the dignified king is:—"May God, the Most High bless his grave."

No. 16.

On the tombstone of his sepulchre, the pen of the decree of God wrote:—"Indeed his tomb is hallowed."

No. 17.

"It was the Qadamgáh of Ḥaẓrat 'Alí."[1]

No. 18.

Abú-l-Gháẓí, Mu'izzu-l-mulk-i-wa-d-dín Sháh Sulṭán Ḥusain Abú-l-Walíd Aḥmad, son of Abú-r-Raẓá of the Ḥanafí sect, a native of Azádán, died in the year two hundred and thirty-two, A. H.

No. 19.

And he is the king of lords and chiefs, the martyr killed unjustly, the diver of the ocean of divine knowledge, and the traveller in the ways of religious observance and spiritual purification, the one chosen to look into the mysteries of God the most powerful, 'Abdu-lláh, son of Mu'áwiyáh, son of Ja'far, son of Abú Ṭálib; may God be pleased with him and with his grandmother, Zainab, the virtuous daughter of the Prophet's daughter, Fáṭimah Zahrá. Through the exertion of the sinful and poor slave, the servant of the descendants of the Prophet, this humble self Shaikh Báyazíd, son of 'Alí al-Mushrif, (this building or tomb was erected) in the year eight hundred and sixty-five, A. H.

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[1] Qadam-gáh—place for the feet to rest on.

No. 20.

Mu'izzu-d-daulat-i-wa-l-mulk-i-wa-d-dín, Báyaqrá, son of the monarch, the fortunate martyr 'Umar Shaikh, son of Tímúr, the Gúrgán, died in the year eight hundred and forty-three, A. H.

No. 21.

He, before whom stand the kings of the dominions of Islám and who is the protection of the monarchy of Kháns, the king of all the quarters of the world, the fruit of the tree of royalty and justice, by inheritance and right, Mu'ínu-s-saltanat-i-wa-d-dunyá-wa-d-dín, Sháh Rukh Sultán, son of the fortunate monarch, Sultán Abú Sa'íd, the Gúrgán, son of the great monarch Sultán Muhammad, son of the great and just monarch, Mírán Sháh, son of the first great monarch Qutbu-l-haqq-i-wa-s-saltanat-i-wa-d-dunyá-wa-d-dín, Amír Tímúr, the Gúrgán, died on the 15th Shawwál, in the year eight hundred and ninety-eight, A. H.

No. 22.

Mu'ínu-s-saltanat-i-wa-d-dunyá-wa-d-dín, Báyasunghur, son of Sháh Rukh, son of Tímúr, died on the 6th Jumádá-l-úlá in the year eight hundred and thirty-six, A. H.

No. 23.

Nizámu-d-dín, Sultán Ahmad, son of 'Abdu-l-Latíf, son of Sultán 'Ubaid, the Gúrgán, son of Sháh Rukh Sultán, died on the 10th Zi-l-hijjah, in the year eight hundred and forty-eight, A. H.

No. 24.

Sultán 'Aláu-d-daulah, son of Ghiyásu-d-daulat-i-wa-d-dín, Báyasunghur, son of the fortunate and praised king, Mu'ínu-s-saltanat-i-wa-d-dunyá-wa-d-dín, Sháh Rukh Sultán, may God enlighten their judgments, died on the 6th of Zi-l-hijjah, in the year eight hundred and sixty-three, A. H.

No. 25.

Ibráhím Sultán, son of 'Aláu-d-daulah, son of Báyasunghur, son of Sháh Rukh, son of Amír Tímúr, died on Thursday, the 18th of the holy month of Ramazán, in the year eight hundred and sixty-three.

No. 26.

This is the tomb of her whom the great God granted power to have together the sovereignty of this world and the happiness of the next, and of whose magnanimity there are left, on the face of the earth, many great and eminent footprints in the path of benevolence. She was Gohar-Shádág͟há, the exalted cradle, the greatest concealed, the Bilqís (the wife of Solomon, the prophet) of her age, the possessor of kingdoms in the countries of religion, the chastity of both the worlds, may God enlighten her judgment. The great calamity (of her death) occurred in the middle of Ramaẓán, in the year eight hundred and sixty-one. O God forgive her!

No. 27.

Shaik͟h Zainu-d-dín, the leader and the chief of the faithful, the Quṭb (saint) having the heaven for his threshold, the G͟hauṡ (saint) possessing the knowledge of the mysterious truths, went out from the low spot of the earth to the height of heaven, with his skirts free from the dust referred to in (the following verse of the Qurán) "I wish I were dust."[1] His age was eighty-one, and this same number, if increased by one year, will represent the year of his death.

[Maulawí Abdul Hak Abid has kindly worked out the various dates, mentioned on p. 99. The date 202 is obtained by adding 81 to the value of the letters of the two words يك سال (91 + 30 = 121); 741 is got by adding 1 to the value of هشتاد یک (30 + 710); and 832 is got by adding 1 to the value of هشتاد یک سال (91 + 30 + 710). By similar processes the following additional dates may be obtained; *viz.*, 831 by adding 740, the value of هشتاد يك (30 + 710), to 91, the value of one سال; again 861 by adding the same 740 to 121, the value of یک سال (91 + 30). Besides several other combinations might be made. But perhaps the date really meant is simply 811, *i. e.*, 1 added on to 81. Ed.]

Three new copper-plate grants of Govindachandra Deva of Kanauj, dated Saṃvat 1180, 1181 *and* 1185. (*With three plates.*)—*By* A. Führer, Ph. D.

No. I.

Raiwán Plate, Saṃvat 1180.

The original plate, containing the inscription now published, is in the Provincial Museum at Lucknow. It was found in April 1885 at Raiwán, a place eight miles north-west from Biswán in the Sítápúr district, in a small kherá, or mound, into which a Bráhman was digging for some private purposes. His Highness Rájá Amír Hasan Khán of Maḥmúdábád acquired the plate and presented it to the Lucknow Museum.

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[1] The infidels will utter these words on the day of resurrection.

The plate (see Plate VI), which is inscribed on one side only, measures 1′ 2¾″ by 11½″; the edges being raised into rims. The inscription is in perfect preservation throughout; but the technical execution is badly done, there being a good deal of clerical mistakes and of misshapen letters. It is composed in Sanskrit and written in Devanágarí characters. The seal is circular, 3″ in diameter; it slides on a plain ring about ½″ thick and 4″ in diameter, which passes through the ring-hole in the top of the plate. The inscribed surface of the seal has suffered a good deal from corrosion; but the traces still visible fully prove that it is identical with the seal of the Basáhí plate* of Govindachandra Deva, of Saṃvat 1161, which has in relief across the centre the legend *Śrímad-Govindachandradevaḥ;* in the upper part Garuḍa, half-man and half-bird, kneeling and facing full front; and in the lower part a *śankha*-shell. The weight of the plate is 5 lbs. 2 oz., and of the seal 2 lbs. 4 oz., total 7 lbs. 6 oz.

The historical information afforded by this plate is the same as that derived from the other four grants of Govindachandra Deva already known.† Of the four ancestors of Govindachandra Deva who are enumerated here as elsewhere, *viz.*, Yas′ovigraha, Mahíchandra, Chandradeva and Madanapála, nothing specific is mentioned beyond this, that Chandradeva acquired the sovereignty over Kanyákubja (Kanauj) and that his kingdom included Benares, Ayodhyá, and ancient Dehlí. Attention may also be drawn to the fact that the sovereignty over Kanyákubja is described in verse 8 as having been newly acquired, even when Govindachandra, the grandson of Chandradeva, was reigning. This seems to indicate that Kanyákubja was lost during the reign of Madanapála and re-acquired by Govindachandra Deva.

The grant was made on Monday, the full-moon day of the month Márgas′irsha, in the (Vikrama) year 1180, answering it appears to Monday, the 21st November 1123 A. D. The king, *Govindachandra*

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* This grant has been edited and translated by Dr. Rájendralála Mitra in the Jour. As. Soc. Beng., Vol. XLII, p. 321 ff. and re-edited by Mr. Fleet in the Ind. Antiquary, Vol. XIV, p. 101. Another grant of the same king, of Saṃvat 1174, has been published by Dr. R. Mitra in the Jour. As. Soc. Beng., Vol. XLII, p. 324 ff. The two original plates are in the Lucknow Museum.

† *Viz.*, the two grants of Govindachandra Deva, of Saṃvat 1161 and 1174, mentioned above; a grant of the same, of Saṃvat 1177, partly edited by Dr. F. E. Hall in the Jour. As. Soc. Beng., Vol. XXXI, p. 123; a grant of the same, of Saṃvat 1182, edited and translated by Dr. F. E. Hall, *ib.* Vol. XXVII, p. 242 ff.

Deva, when making the grant, was at Benares; the donee was the Bráhman *Ṭhakkura Báládityaśarmá* of the *Paráśara* class *(gotra)*; and the object granted was the village of *Sohanjaka* in the *Navagráma* district (*pattalá*). I am unable to identify these places.

*Text.**

[1] ओं स्वस्ति ॥ वैकुण्ठोत्कण्ठवै: ।कण्ठपीठलुठत्करः ॥ संरम्भः सुरतारम्भे स श्रियः श्रेयसेसु वः ॥ [१ ॥] आसीदसीतद्युतिवन्स-

[2] जातक्ष्मापालमालासु दिवङ्गतासुः । साक्षादिवस्वानिव भूरिधाम्ना नाम्ना यशोविग्रह इत्युदारः ॥ [२ ॥] तत्सुतोभून्महीचंद्रश्च-

[3] न्द्रधामनिभं निजं । येनापारमकूपारपारे व्यापारित यसः ॥ [२ ॥] तस्याभूत्तनयो नयै-करसिकः क्रान्तद्विषन्मण्डलो विध्वस्तो-

[4] द्धतवीरयोधतिमिरः श्रीचंद्रदेवो नृपः ॥ येनोदारतरप्रतापसमिताशेषप्रजोपद्रवं ॥ श्रीमद्गा-धिपुराधिराध्यमसमन्दोर्व्विक्र-

[5] मेणार्ज्जितं ॥ [४ ॥] तीर्थानि कासिकुसिकोत्तरकोसलेन्द्रःस्थानीयकानि परिपालयताभि-गम्य [।] हेमात्मतुल्यमनिशं ददता द्विजभ्यो येना-

[6] ङ्किता वसुमती सततन्तुलाभिः ॥ [५ ॥] तस्यात्मजो मदनपाल इति क्षितीन्द्रचूडामणि-र्व्विजयते निजगोत्रचंद्रः । यस्याभिषेककलशोल्ल-

[7] सितैः पयोभिः प्रक्षालित वालिरजः पटलं धरित्याः ॥ [६ ॥] यस्याशीद्विजयप्रयाण-समये तुङ्गाचलोच्चस्खलन्माद्यत्कुम्भिपदःक्रमासम-

[8] भरभ्रस्यन्महीमण्डले ॥ चूडारत्नविभिन्नतालुगलितस्त्यानासृगुद्भासितः शेषः पेषवशादिव क्षणमसौ क्रोडे निलीनाननः ॥ [७ ॥]

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* From the original plate.

L. 1. The second stroke after °लुठत्करः superfluous. Read श्रेयसेस्तु; आसीदशीत° ; °वंश- ।

L. 2. Omit the visarga after गतासु ।

L. 3. Read व्यापारितं यशः ।

L. 4. The second stroke after नृपः superfluous; read °शमित° ; the sign after उपद्रवं superfluous; °राज्य° ।

L. 5. Read काशिकुशिकोत्तरकोशलेन्द्रस्थानीयकानि ; अधिगम्य ; द्विजेभ्यो ।

L. 6. Read प्रक्षालितं कलिरजः ; धरित्र्याः ; यस्यासीद्वि° ; तुङ्गाचलोच्चैस्खलन्माद्यत्कुम्भिपदक्रमासम- । A grant of Madanapála, of Saṃvat 1154, published by Dr. F. E. Hall in the Jour. As. Soc. Beng., Vol. XXVII, p. 220 ff., reads सकलं instead of पटलं ।

L. 8. भरभ्रश्यन् ; the second stroke after °मण्डले superfluous; read असृगुद्भासितः ; शैषवशादिव । शैष being a synonym of शिशिर according to *Hemachandra.*

[9] तस्माद्जायत निजायतबाहुवल्लिबन्धरवरुद्धनवराष्यगजो नरेन्द्रः ॥ सान्द्रामितद्रवमुचां
प्रभयो गवां यो गोविन्दचन्द्र इति चन्द्र

[10] इवांबुराषेः ॥ [८ ॥] न कथमप्यलभन्त रणक्षमांस्तिस्रषु दिक्षु गजानथ वज्रिणः । ककु-
भि बभ्रमुरभ्रमवल्लभप्रतिभय इप यस्य घटाग-

[11] जाः ॥ [९ ॥] सोयं समस्तराजचक्रसंसेवितचरणः ॥ परमभ ।रकमहाराजाधिराजपरमे-
श्वरपरममाहेश्वरनिजभुयोपार्ज्जि-

[12] तश्रीकन्यकुब्जाधिपत्यश्रीचंद्रदेवपादानुध्यात । परमभट्टारकमहाराजाधिराजपरमेश्वर-
परममाहेश्वरश्रीमन्मदनपा-

[13] लदेवपादानुध्यात । परमभट्टारकमहाराजाधिराजपरमेश्वरपरममाहेश्वराश्वपतिगजपति-
नरपतिराजत्रयाधिप-

[14] तिविविधविद्याविचारवाचस्पतिश्रीमद्गोविन्दचंद्रदेवो विजयी ॥ नवगामपत्तलायां । सोढं-
जकग्रामभलुरीपाठकनस-

[15] न्निवासिनो निखिलजनपदानुपगतानपि च राजराज्ञीयुवराजमंत्रिपुरोहितप्रतीहार-
सेनापतिभांडागारिकाक्षप-

[16] इलिकभाषग्नैमितिकान्तःपुरिकदूतकरितुरगपत्तनाकरस्थानगोकुलाधिकारिपुरुषानाज्ञा-
पयति वोधयत्यादिस-

[17] ति च यथा [।] विदितमंस्तु भवतामुपरिलिखितग्रामः सजलस्थलः सलोहलवणाकरः
समत्स्याकरः सगर्त्तोषरः सम-

[18] धूकाम्ववनवाटिकाविटपत्तिणयूतिगोचरपर्यन्तः सोर्द्धाधश्चतुराघाटविशुद्धः स्वसीमापर्यन्तः
संवत् ११८० मार्यसुदि

[19] पौर्णमास्यां तिथौ सोमदिने ॥ अद्येह श्रीमद्वाराणस्या संक्रान्तौ देवश्रीआदिकेशवघट्ट
गंगायां स्नात्वा विधिवन्मन्त्रदेव-

[20] मुनिमनुजभूतपितृगणास्तर्प्पयित्वा तिमिरपटलपाटनपटुमहसमुष्णरोचिषमुपस्थायोषधिप-
तिशकलशेषरं सम-

L. 9. Read ०बन्धाव० ; ०राज्य० ; the second stroke after नरेन्द्रः superfluous ; read सान्द्रामृत० ; प्रभवो ।

L. 10. Read ०राशेः ;०तिसृषु ; ०प्रतिभटा इव ।

L. 11. The sign after ०चरणः superfluous ; read ०परमेश्वरपरममाहेश्वरनिजभुजो० ।

L. 12. Read ०चन्द्रदेवपादानुध्यातपरम० ; ०परमेश्वरपरममाहेश्वरश्रीमन्मदनपा- ।

L. 13. Read ०देवपादानुध्यातपरम० ; ०परमेश्वरपरममाहेश्वर० ।

L. 14. The signs after विजयी and नवग्रामपत्तलायां superfluous; read सोढजक-ग्रामभलुरीपाठकस- ।

L. 16. Read ०डलिकभिषङ्नैमित्तिका० ; बोधयत्यदिस- ।

L. 17. Read विदितमस्तु ।

L. 18. Read धूकाम्र० ; ०तृण० ; मार्गसुदि ।

L. 19. Read ०वाराणस्यां ।

L. 20. Read ०गणांस्तर्पयित्वा ; ०यौषधिपतिशकलशेखरं ।

[21] खल्वे त्रिभुवनचातुर्वोसुदेवस्य पूर्जां विधाय प्र ुरनस्थावयन हविषा हविर्भुजं हुत्वा मातारिपोरात्मनश्च पुण्ययशोभिः

[22] हदथे चक्षभिर्गोकर्णकुशलतापूतचारतलोदधापूर्वं । परासरगोचाय । पराशरत्रिगोचाय वसिष्ठसचातिपारासर-

[23] त्रिप्रवराय ठक्कुरश्रीदामोदरपौचाय ठाकुरश्रीमहादित्यपुचाय ठक्कुरश्रीवाशादित्यशर्मणे प्राम्हणाय चंद्रार्कं

[24] यावच्छाशनीकृत्य प्रदत्तो मत्वा यथादीयमानभागभोगकरप्रवणिकरतुरुष्कदंडकुमारग-दियाणेचाप्रभृतीनसमस्ता-

[25] दायानाज्ञाविधेयीभूय दास्यथः ॥ भवन्ति चात्र श्लोकाः । भूमिं यः प्रतिगृह्णाति यश्च भूमिं प्रयच्छति [।] उभे तौ पुण्यं-

[26] कर्माणौ नायतौ स्वर्गगामिनौ ॥ [१० ॥] स्वदत्तां परदत्तां वा यो हरेत्तु वसुंधरा । स विष्ठायां कृमिर्भूत्वा पितृभिः सह मज्जति ॥ [११ ॥] त-

[27] डागाना सहस्रेण वाजपेयशतेन च । गवां कोटिप्रदानेन भूमिंहर्ता न शुध्यति ॥ [१२ ॥] षष्टिवर्षसहस्राणि स्वर्गे वसति

[28] भूमिदः । आच्छेता चानुमन्ता च तान्यव नरके वसेत ॥ [१३ ॥] कारयिकठक्कुरश्रीविश्वरूपेण तांम्र-

[29] पट्टक लि[खि]तमिति ॥

Translation.

Oṃ! May it be well! (v. 1). May the agitation of Lakshmí during the amorous dalliance, when her hands wander over the neck of Vaikuṇṭha (Vishṇu) filled with eager longing, bring you happiness!

(v. 2.) After the lines of protectors of the earth born in the solar race had gone to heaven, there came a noble (personage) *Yaśovigraha* by name, (who) by his plentiful splendour (was) as it were the sun incarnate.*

(v. 3.) His son was *Mahíchandra* who spread his boundless fame, resembling the moon's splendour, (*even*) to the boundary of the ocean.

L. 21. Read त्रिभुवनचातुर्वेद्यसुदेवस्य ; हविषा ; मातापित्रोरात्मनश्च पुण्ययशोभि- ।

L. 22. Read हस्तेनाभिर्गोकर्णकुशलतापूतकरतलोदकपूर्वं पाराशरगोत्राय वसिष्ठ-शक्तिपराशर- ।

L. 23. Read ठक्कुर॰ thrice; ॰पौत्राय ; ॰वासादित्यशर्मणे ब्राह्मणाय ।

L. 24. Read यावत् ; ॰प्रवणिकरतुरुष्कदण्डकुमारगद्याणकरप्रभृतीन् समस्ता- ।

L. 25. Read दास्यथ ; श्लोकाः ; प्रतिगृह्णाति ; भूमिं ; उभौ ; पुण्य- ।

L. 26. Read नियतं स्वर्ग॰; हरेत वसुन्धरां ।

L. 27. Read तडागानां सहस्रेणाश्वमेधशतेन च ; गवां ; भूमिहर्ता न शुध्यति ; ॰वर्ष॰ , स्वर्गे ।

L. 28. Read आच्छेत्ता चानुमन्ता ; तान्येव ; वसेत् ; ॰ठक्कुरश्रीविश्वरूपेण ताम्र-

L. 29. Read पट्टकं

* Metre: Indravajrá.

(v. 4.) His son was the king, the illustrious *Chandradeva*, whose one delight was in statesmanship, who attacked the hostile hosts (and) scattered the haughty brave warriors (as the moon does) the darkness. By the valour of his arm he acquired the matchless sovereignty over the glorious Gádhipura,* when an end was put to all distress of the people by his most noble prowess.†

(v. 5.) Protecting the holy bathing-places of Káśí (Benares), Kuśika (Kanauj),‡ Uttarakośalá (Ayodhyá), and the city of Indra (Indrasthána, ancient Dehlí),§ after he had obtained them, (and) incessantly bestowing on the twice-born gold equal (in weight) to his body, he eternally|| marked the earth with the scales (on which he had himself weighed).¶

(v. 6.) Victorious is his son *Madanapála*, the crest-jewel of the rulers of the earth, the moon of his family. By the sparkling waters from his coronation-j[illegible] the coating of the impurity of the Kali yuga (the present, or iron-age) was washed off from the earth.*

(v. 7.) When he went forth to victory, the orb of the earth bent down beneath the excessive weight of the footsteps of his rutty elephants marching along, tall as towering mountains: then, as if suffering from cold, S'esha, radiant with the clotted blood that trickled from his palate pierced by the crest-jewel, hid his face for a moment in his bosom.†

(v. 8.) As the moon, whose rays diffuse in abundance liquid nectar,‡ from the ocean, so was born from the ruler of men *Govindachandra Deva*, who bestowed cows giving abundant milk. As one restrains an (untrained) elephant, so he secured by his creeper-like long arms the new (*i. e.*, newly acquired) kingdom.§

(v. 9.) When his war-elephants had in three quarters in no wise found elephants their equals for combat, they roamed about in the

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* Gádhipura, 'town of Gádhi,' the father of Viśvámitra, is Kanyákubja, or Kanauj.

† Metre: S'árdúlavikríḍita.

‡ Kuśikatírtha is apparently Gádhipura, or Kanyákubja, as Kuśika is the father of Gádhi.

§ Indrasthána is very probably another name for Indraprastha, or ancient Dehlí.

|| The two Benares grants read distinctly शतशस्तुलाभिः, *i. e.*, hundreds of times.

¶ Metre: Vasantatilaká.

* Metre: Vasantatilaká.

† Metre: S'árdúlavikríḍita.

‡ This translation is based on the readings of the two Benares grants.

§ Metre: Vasantatilaká.

region of the wielder of thunderbolt, (*i. e.*, the East), like rivals of the mate of Abhramu.*

(L. 11.) He it is who has homage rendered to his feet by the circle of all rájas; he, the most worshipful, the supreme king of mahárájas, the supreme lord, the devout worshipper of Máheśvara (Vishṇu), the lord over the three rájas, (*viz.*) the lord of horses (*aśvapati*), the lord of elephants (*gajapati*) and the lord of men (*narapati*),† (like) Bṛihaspati investigating the various sciences, the illustrious *Govindachandra Deva,* who meditates on the feet of the most worshipful, the supreme king of mahárájas, the supreme lord, the devout worshipper of Máheśvara, the illustrious *Madanapála,* who meditated on the feet of the most worshipful, the supreme king of mahárájas, the supreme lord, the devout worshipper of Máheśvara, the illustrious *Chandradeva,* who by his own arm acquired the sovereignty over Kanyákubja :—

(L. 14.) He, the victorious, commands, informs and decrees to all the people assembled, resident at the village of *Sohanjaka,* a part of *Baluri,* in the *Navagráma* district, and also to the *rájas, rájñís* (queens), *yuvarájas* (heirs-apparent), counsellors, chaplains, warders of the gate, commanders of the troops, treasurers, keepers of records, physicians, astrologers, superintendents of gynaeceums, messengers, and to officers having authority as regards elephants, horses, towns, mines (*ákara*), districts (*sthána*), cattle-stations, as follows :—

(L. 17.) Be it known to you that, after having bathed here today in the Ganges at the divine and blessed A'dikeśavaghaṭa,‡ at the glorious Váráṇasí (Benares), on the occasion of the sun's entrance into another zodiacal sign after midnight, after having duly satisfied the sacred texts, divinities, saints, men, beings and the groups of ancestors, after having worshipped the sun whose splendour is potent in rending the veil of darkness, after having praised him whose crest is a portion of the moon, (*i. e.*, S'iva), after having performed adoration of Vásudeva (Vishṇu incarnate as Kṛishṇa), the protector of the three worlds, after having sacrificed to fire (Agni) an oblation of clarified butter with abundant milk, rice and sugar,—we have, in order to increase the (spiritual) merit and the fame of our parents and of ourself, on Monday, the day of full-moon of Márgaśírsha ṣudi, in the (Vikrama) Saṃvat year 1180,—given the above-written village with its water and dry land, with its mines of iron and salt, with its fisheries, with its ravines and saline waters, with and including its groves of *madhúka* and mango trees, enclosed gardens, bushes, grass and pasture land, with what is above and below, defined as to its four abuttals, up to its proper boundaries, to the *Ṭhakkura*, the illustrious *Báládityaśarmá*, Bráhman, son of the *Ṭhakkura*, the illustrious *Mahâditya*, grandson of the *Ṭhakkura*, the illustrious *Dámodara*, of the Paráśara clan (*gotra*) (and) whose three *pravaras* (ancestors) are Vaśishṭha, S'akti, and Paráśara,—(confirming our gift) with (the pouring out) from the palm of our hand, shaped like a cow's ear,* (of) water purified with *kuśa* grass (and) ordaining (that it shall be his) as long as moon and sun (endure). Aware (of this), you, being ready to obey (our) commands, will make over (to him) every kind of income, the due share† of the produce, the money-rent (*pravaṇikara*),‡ the taxes on aromatic reeds (*turushkadaṇḍa*),§ the taxes on royal mace-bearers and eunuchs,|| and so forth.

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* Metre: Drutavilambita. Abhramu is the female elephant of the East (the region of Indra), the mate of Airávata.

† The aśvapati, gajapati, and narapati are high officers of state.

‡ The quay of A'dikeśava, or Vishṇu, still maintains its reputation for sanctity at Benares.

(L. 25.) And on this (subject) there are (the following) verses: (v. 10.) Both, he who accepts land and he who grants it, are equally meritorious, and they go certainly to heaven.

(v. 11.) Whoever robs land whether given by himself or by others, becoming a maggot, sinks with his parents into ordure.

(v. 12.) The alienator of land-grants cannot expiate his crime even (by dedicating to public use) a thousand tanks, by (performing) a hundred horse-sacrifices, and by giving away in charity ten millions of cattle.

(v. 13.) The donor of land dwells in heaven for the space of sixty thousand years; the resumer, and the abetter thereof, are doomed to abide in hell for a like period.

(L. 28.) This copper-plate grant has been written by the *káyastha*, the *Ṭhakkura*, the illustrious *Viśvarúpa*.

No. II.

Benares Plate (A), of Saṃvat 1181.

This plate and the following, No. III, were sent by Mr. J. H. Rivett-Carnac, C. S., C. I. E., in September 1886, to the Lucknow Museum; but as their owner, Sítárám Agarwálá of Benares, asked the absurd price of Rs. 250, the offer was not accepted. At the request of the owner, they were forwarded to Surgeon-Major Dr. G. C.

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* Several *śikshás* prescribe that at the recitation of Vedic texts the right hand should be so held as to look like a cow's ear.

† *Viz.*, the tenth of the produce.

‡ This word has generally been translated with 'tolls on quadrivials'; but it takes here as elsewhere the place of the usual *hiraṇya*.

§ This expression has by Dr. F. E. Hall, *l. c.*, been taken to mean "Muḥammadan amercements."

|| These taxes I have not met with anywhere else.

Hall of the Naini Jail, in whose possession they now are. No information is forthcoming as to where they were originally found.

Plate A (see Plate VII) which is inscribed on one side only, measures 1′ 2¼″ by 11½″. It is quite smooth, the edges being neither fashioned thicker nor raised into rims. The right corner is broken off, and the inscription has been very much defaced by rust, making it quite illegible in some places. Yet the lost portions can easily be restored with the help of the preceding record, as they are of no material importance. The inscription is composed in Sanskrit and written in Devanágarí characters. There is a ring-hole in the top of the plate, but the ring and seal are lost. The weight of the plate is 8 lbs.

The grant is dated Thursday, the 4th lunar day of the bright half of the month Bhádrapada of the (Vikrama) year 1181, answering it appears to Thursday, the 9th September 1124 A. D. The king *Govindachandra Deva,* when making the grant was at Benares; the donee was the Bráhman *Paṇḍita Bhúpati Śarmá* of the *Mauneya gotra;* and the object granted was the village *Tribháṇḍí* in the *Yavaala* district, which places I am unable to identify.

Text.*

[1] ओं स्वस्ति [॥] अकुण्ठोत्कण्ठवैकुण्ठकण्ठपीठलुठत्करः [।] संरम्भः सु[रतारम्भे] स श्रियः श्रेयसेस्तु वः । [। १ ॥] आसीद[शी]तद्युतिवं[शजात]क्ष्मापाल-

[2] मालासु दिवं गतासु । साक्षाद्विवस्वानिव [भू]रिधाम्ना नाम्ना [यशो]वि[ग्रह इ]त्युदार[:॥२॥ तत्सु]तोभून्महीचन्द्रश्चन्द्रधामनिभं नि[जं ।]

[3] येनोपारमकूपार[पारे व्या]पारितं यशः [॥ ३ ॥] तस्याभूत्तनयो न[यैकरसि]कः क्रान्तद्विषन्म[ण्डलो] विध्वस्तोद्धतवीरयोधतिमि[रः] श्रीचन्द्रदेवो

[4] [नृपः ।] ये[नो]दारतरप्रतापशमिताशेषप्रजोपद्रवं श्रीमद्गाधि[पु]रा[धि]राध्यमसमं दो[र्वि]क्रमेणार्ज्जितम् ॥ [४ ॥] तीर्थानि कासिकु[शि]कोत्तरको-

[5] शलेन्द्रस्थानीयकानि परिपालय[ताधिग]म्य [।] हेमात्मतुल्यमनिशं दद[ता] द्विजेभ्यो येनाङ्किता वसुमती शतशस्तुलाभिः ॥ [५ ॥] तस्यात्मजो मद-

[6] नपाल इति क्षितीन्द्रचूडामणिर्व्विज[यते] निजगोत्रचन्द्रः । य[स्या]भिषेक[कलशोल्ल-]सितैः पयोभिः प्रक्षालितं कलिरजः पटल धरित्र्याः [॥ ६ ॥]

[7] यस्यासीद्विजयप्रयाणसमये तुङ्गाचलोच्चै[श्च]लन्माद्यत्कु[म्भि]पदक्रमासमभरभ्रस्यन्महीमंडले चूडारत्नविभिन्नतालुगलितस्त्यानासृगु-

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* From the original plate.

L. 3. Read येनापारमकूपपारपारे ।

L. 4. Read °राज्य° ; काशि° ।

L. 6. Read पटलं ।

L. 7. Read °भ्रश्यन्महीमण्डले ।

[8] क्षालितः शेष[ः] पैयसा[दि]व यशसो श्रोके त्रिलोकामलः ॥ [७ ॥] तस्मादज[ाय]त निजायतवा- वल्लिवद्धाववद्धनवराज्यगजो नरेन्द्रः । सान्द्रामृत-

[9] द्रवमुचां प्रभवो गवां यो गोविन्दचन्द्र इति चन्द्र इवाम्बुरा[शे]ः ।[। ८ ॥] न क[थमप्यल-भ]न्त रणक्षमास्तिसृषु दिक्षु गजनथ वज्रिणः । ककुभि ब[भ्र]मुर-

[10] [भ्रमु]वल्लभप्र[तिभ]टा इव यस्य घटागजाः ॥ [९ ॥] स ॥ सोयं समस्तराज[च]क्रसंसेवित-चरणः परमभट्टारकमहाराजाधिराजपरमेश्वरपरममा-

[11] हे[श्वरनिजभु]जोपार्ज्जितश्रीकन्य[कु]ब्जाधिपत्यश्रीचन्द्रदेवपादानुध्यातपरमभट्टारकमहारा-जाधिराजपरमेश्वरपरममाहेश्वरश्रीमदनपा-

[12] लदेवपादानुध्यातपरम[भट्टा]रकमहाराजा[धि]राजपर[मेश्व]रप[रममाहे]श्वराखपतिग-जपतिनरपतिराजत्रयाधिपतिविविधविद्याविचा-

[13] [रवा]चस्पतिश्रीमद्गोविन्दचन्द्रदेवो वि[ज]यी ॥ यवचञ्चपत्तलायां [विभा]वैग्रामनि-वासिनो निखि[लज]नपदानुपगतानपि च राजराज्ञीयुवराज-

[14] [मन्त्रि]पुरोहितप्रती[हार]सेनाप[तिभाण्डाग]ारिकाक्षपट[लिकभि]षगनैमित्तिकान्तःपु-रिकदूतकरि[तुर]गपत्तनाकरस्थानगोकुलाधिकारि-

[15] पुरु[षांश्च समा]ज्ञापयति[बा]दिशति बोधयति च ॥ यथोपरिलि[खितग्र]ामः सजलस्थलः सलोह[लव]णाकरः समत्स्याकरः सगर्त्तोषरः समधूक[ाकरः]

[16] [स]चूतव[नवाटि]काचि[टपी]तृणयू[तिगोच]रप[र्य्यन्तः] सोर्द्धाधश्चतु[र]ाघाटविशुद्धः स्व-[सीमाप]र्य्यन्तः सम्वत् ११८१ भाद्रपदसुदि ४ गुरौ [॥]

[17] अद्येह [श्रीमद्वारा]णस्या गंगायां स्नात्वा विधिवन्मंत्रमनुजभूतपितृगणांस्तर्प्पयित्वा ति-[मिर]पाटलपटलपटुमहसमुष्णरोचिषमुपस्था-

[18] [यौषधि]पतिशकलशेखरं समभ्यर्च्य त्रिभुवनत्रातुर्वासुदेवस्य पूजां विधाय हविष[ा ह-]विर्भुज हुत्वा मातापित्रोरात्मनश्च पुण्ययशो-

[19] [भिवृद्ध]ये गोकर्णकु[शल]तापूतकरतलोदकपूर्वम् श्रीमद्राजसंस्थन्नामहामाहराज्ञीश्री-हाल्हणदेविभिर्म्मामसगो-

[20] [त्रा]य गा[धे]यभार्गववैतहव्य । त्रिप्रवराय । पंडितश्रीमहीपतिपौत्राय पंडितश्रीनार-पुत्राय । पंडितश्रीभोपतिसर्म्मणे ग्रा-

L. 8. Read शेषवशादिव ; बाहुवल्लिबन्धा॰ ; ॰राज्य ।

L. 9. Read रणक्षमांस्तिसृषु ; गजानथ ।

L. 12. Read ॰श्वपति॰ ।

L. 13. Read यवचञ्चपूत्तलायां ।

L. 14. Read ॰भिषक्नै॰ ।

L. 15. Read समाज्ञापयत्यादिशति ; the sign after च is superfluous.

L. 16. Read सोर्ध्वाधश्चतुराघाटविशुद्धः ।

L. 17. Read श्रीमद्वाराणस्यां गङ्गायां ।

L. 18. Read शकलशेखरं ; ॰हविर्भुजं ।

L. 19. Read श्रीमद्राजसामन्तमहामाहराज्ञीश्रीहाल्हणदेवीभिर्म्मानेयसगो- ।

L. 20. Read गाधेयभार्गववैतहव्यत्रिप्रवराय पण्डितश्रीमहीपतिपौत्राय पण्डितश्रीनर-पतिपुत्राय पण्डितश्रीभपतिशर्म्मणे ग्रा- ।

[21] ष्णाय[। आ]चंद्राक्कं यावच्छासनीकृत्य परयाभक्तमहादाने प्रदत्तो मत्वा य[था]दीय-
मानभागभोगकरप्रवणिकरतुरुष्क-

[22] दंडप्र[भृ]ति[स]र्वादायान् आज्ञाविधेयीभूय दास्यथेति ॥ छ ॥ भवन्ति चात्र श्लोक[ाः] ॥
भूमि यः प्रति[गृ]ह्णाति । यश्च भूमि प्रयच्छर्थि ।

[23] उभौ तौ पुण्यकर्म्माणौ । नयंतौ स्वर्ग्गगामिनौ ॥ [१० ॥] बहुभिर्व्वसुधा भुक्ता राजा[भिः]
सगरादिभि येस्य [य]स्य यदा भूमिस्त[स्य तस्य तदा]

[24] फल ॥ [११ ॥] गामेकां स्वर्णमेकं च भूमेरप्येकमङ्गुलं [।] हरन्नरकमाप्नोति यावदाभूतसंप्ल-
वम् ॥ [१२ ॥] वारिहीनपुरण्यिप शुष्क[कोट-]

[25] रवासिनः [।] कृष्णसर्प्पाश्च जायन्ते देवब्रह्मस्वहारिणः ॥ [१३ ॥] षष्ठिवर्षसहस्राणि स्वर्ग्गे
वसति भूमिदः [।] आच्छेत्ता चानु[मन्ता च ता-]

[26] न्येव नरके वसेत् ॥ [१४ ॥] वाताभ्रविभ्रममिदं वसुधाधिपत्यमापातमात्रमधुरा विषयोप-
भोगाः । प्राणास्तृणाग्रजल[बिन्दुसमा न-]

[27] राणा धर्म्मः सखा परमहो परलोकयाने ॥ [१५ ॥] यानीह दत्तानि पुरा नरेन्द्रैर्दानानि
धर्म्मार्थयसस्क[राणि ।] निर्म्माल्य[वान्तप्रति-]

[28] मानि तानि को नाम साधुः पुनराददीत ॥ [१६ ॥] संखं भद्रासनं छत्रं वराश्वा वार-
वारणा[ः ।] भूमिदानस्य चिह्नानि फलमे[तत्पुरन्दर ॥ [१७ ॥]]

[29] लिखितं चेदं ताम्रं ठक्कुरलिखि०. ।रश्रीश्रीचंद्रेणः ॥ मंगलं महाश्रीः ॥

Translation.

Oṃ! May it be well!—(verses 1 to 9 = verses 1 to 9 of the preceding.)

(l. 10.) He it is who has homage rendered to his feet by the circle of all rájas; he, the most worshipful, the supreme king of mahárájas, the supreme lord, the devout worshipper of Máheśvara, the lord over the three rájas, (*viz.*), the lord of horses, the lord of elephants, and the lord of men, (like) Bṛihaspati investigating the various sciences, the illustrious *Govindachandra Deva*,—who meditates on the feet of the most worshipful, the supreme king of mahárájas, the supreme lord, the devout worshipper of Máheśvara, the illustrious *Madanapála*, who meditated on the feet of the most worshipful, the supreme king of mahárájas,

L. 21. Read ष्णायाचन्द्रार्कं ।

L. 22. Read दण्डप्रभृतिसर्वादायानाज्ञाविधेयीभूय ; श्लोकाः, भूमिं ; the sign after प्रतिगृह्णाति is superfluous ; भूमिं प्रयच्छति ।

L. 23. Read पुण्यकर्माणौ नियतं स्वर्ग० ; सगरादिभिः । यस्य.

L. 24. Read फलं; संप्लवम् ; वारिहीनेष्वरण्येषु शुष्क० ।

L. 25. Read षष्टिं वर्षसहस्राणि ।

L. 27. Read राणां ; धर्मार्थयशस्कराणि ।

L. 28. Read शङ्खं ; वराश्वा वरवारणाः ।

L. 29. Read ताम्रपट्टं ठक्कुरलेखिठक्कुरश्रीश्रीचन्द्रेण ॥

the illustrious *Chandradeva*, who by his own arm had acquired the sovereignty over Kanyákubja:—

(l. 13.) He, the victorious, commands, informs and decrees to the people assembled, resident at the village of *Tribhaṇḍí*, in the *Yavaala* district, and also to the rájas, rájñís, yuvarájas, counsellors, chaplains, warders of the gate, commanders of troops, treasurers, keepers of records, physicians, astrologers, superintendents of gynecaeums, messengers, and to the officers having authority as regards elephants, horses, towns, mines, districts, cattle-stations, as follows:—

(l. 15.) After having bathed here to-day in the Ganges, at the illustrious Váráṇasí (Benares), after having duly satisfied the sacred texts, men, beings and the groups of ancestors, after having worshipped the sun whose splendour is potent in rendering the veil of darkness, after having praised him whose crest is a portion of the moon (S'iva), after having performed adoration of Vásudeva (Kṛishṇa), the protector of the three worlds, after having sacrificed to fire an oblation of clarified butter, I have, in order to increase the (spiritual) merit and the fame of my parents and myself, and with the consent of the illustrious rájas, feudatory princes (sámanta), and the great lady, the queen, the illustrious *Dálhaṇadeví*,* at the occasion of giving the valuable present of a plough to the highest, (*i. e.*, Bráhmans),† on Thursday, the 4th lunar day of the bright half of Bhádrapada, in the (Vikrama) Saṃvat year 1181,—given the above-written village with its water and dry land, with its mines of iron and salt, with its leaves (parṇákara),‡ with its ravines and saline wastes, with its fisheries, with and including its groves of mango trees, enclosed gardens, bushes, grass and pasture land, with what is above and below, defined as to its four abuttals, up to its proper boundaries, to the Bráhman, the *Paṇḍita*, the illustrious *Bhúpatiśarmá*, son of the Paṇḍita, the illustrious *Narapati*, grandson of the Paṇḍita, the illustrious *Mahípati* of the *Mauneya gotra* (and) whose three *pravaras* are Gádheya (Viśvámitra), Bhárgava (Chyavana), and Vaitahavya (Aruṇa),—(confirming my gift) with (the pouring out) from my hand, shaped like a cow's ear, (of) water purified with kuśa-grass, (and) ordaining (that it shall be his) as long as moon and sun (endure). Aware (of this), you, being ready to obey (my) commands, will make over to him the due share of the produce, the money-rent, the taxes on aromatic reeds, and so forth.

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* This is the only instance where the name of Govindachandra Deva's consort occurs.

† Sixteen such valuable gifts (*mahádána*) are particularly enumerated in the *Gṛihyasútras*.

‡ *Viz.*, the pán, or betel-leaves.

(l. 22.) And on this (subject) there are (the following) verses : (v. 10.) Both, he who accepts land and he who grants it, are equally meritorious, and they go certainly to heaven.

(v. 11.) This earth has been enjoyed by many kings, including Sagara (king of Ayodhyá) and others. To whomsoever belongs the earth for the time being, he enjoys the fruit (of such gifts).

(v. 12.) He who robs a cow, a gold coin (svarṇa = suvarṇa), or a finger's breadth of land, dwells in hell until the dissolution of universe.

(v. 13.) The resumers of land dedicated to gods and Bráhmans, become dwellers in arid wastes, avoid of water, and dry hollows in trees, and are born as black serpents.

(v. 14.) The donor of land dwells in heaven for the space of sixty thousand years; the resumer, and the abetter thereof, are doomed to abide in hell for a like period.

(v. 15.) Sovereignty is like unto clouds impelled by wind, (*i. e.*, inconstant), worldly pleasures are sweet only for the moment, the life of man is but a drop of water at the point of a blade of grass; virtue verily is the only great friend for translation to a future world.*

(v. 16.) All the gifts of former kings are productive of virtue, wealth and fame,—how can he, who claims the name of goodness, resume them but as emblems of vomited food.†

(v. 17.) A conch-shell, a throne, an umbrella, choice horses, and excellent elephants, oh Purandara (Indra), are the royal insignia which constitute the reward of giving away land.

(l. 29.) And this copper-plate grant has been written by the respectable *káyastha*, the *Ṭhakkura*, the illustrious (and) venerable *Chandra*. (May) favourable fortune (and) great felicity (attend) !

No. III.

Benares Plate (B), of Saṃvat 1185.

As regards the history of this grant, see the preceding inscription.

Plate B (see Plate VIII), which is inscribed on one side only, measures 1′ 5″ by 12¾″. It is quite smooth, the edges being neither fashioned thicker nor raised into rims. The plate is broken into two parts in the middle, but the inscription is in perfect order throughout; it is composed in Sanskrit and written in Devanágarí characters. There is a ring-hole in the top of the plate, but the ring and seal are not forthcoming. The weight of the plate is 11 ℔s.

The grant is dated Friday, the 15th lunar day of the bright half of Chaitra of the (Vikrama) year 1185, answering it appears to Friday, the 20th March 1128 A. D. The date is given both in letters and figures. The king *Govindachandra Deva,* when making the grant, was at Benares; the donee was the same Bráhman, mentioned in the preceding grant, *Paṇḍita Bhúpatiśarmá* of the *Mauneya gotra;* and the object granted was the village of *Jara* in the *Puroha* district, which places I am unable to identify.

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* Metre : Vasantatilaká.

† Metre : Vasantatilaká.

This grant is of considerable historical value as it proves that Govindachandra Deva was still reigning in Saṃvat 1185, or 1128 A. D.

*Text.**

[1] ओं स्वस्ति [॥] अकुण्ठोत्कण्ठवैकुण्ठकंठपीठलुठत्करः [।] सरम्भः सुरता[र]म्भे स श्रियः श्रेयसेस्तु वः [॥ १ ॥] आसीदसीतद्युतिवम्सजातःक्ष्मापालमालासु दिवं
[2] गतासु [।] साक्षाद्विवस्वानिव भूरिधाम्ना नाम्ना यशोविग्रह इत्युदारः । [। २ ॥] तत्सुतो-ऽभून्महीचन्द्रश्चन्द्रधामनिभं निजं [।] येनापारमकूपारपारे व्यापारि यशः । [।
[3] ३ ॥] तस्याभूत्तनयो नयैकरसिक आक्रान्तद्विषन्मंडलो विद्धस्तोद्धतवीरयोधतिमिर श्रीचन्द्र-देवो नृपः [।] येनोदारतरप्रतापसमिताशेषप्रजोपद्रवं
[4] श्रीमद्गाधिपुराधिराज्यमसमन्दोर्व्विक्रमेणार्ज्जितं [॥ ४ ॥] तीर्थानि काशिकुसिकोत्तरको-स्लेन्द्रस्थानीयकानि परिपालयताभिगम्य [।] हेमात्मतुल्यमनिसं ददता द्विजे-
[5] भ्यो येनाङ्किता वसुमती सतसस्तुलाभिः [॥ ५ ॥] तस्यात्मजो मदनपाल इति क्षितीन्द्र-चूडामणिर्व्विजयते निजगोत्रचन्द्रः [।] यस्याभिषेककलसोल्लसितैः पयोभिः ।
[6] प्रक्षालितं कलिवजः पटलं धरित्र्याः । [। ६ ॥] यस्यासीद्विजयप्रयाणसमये तुङ्गाचलोच्च-चलन्माद्यत्कुंभिपदक्रमासमभरभ्रस्यन्महीमण्डले [।] चूडारत्नविभिन्न-
[7] तालुगलितस्त्यानासृगुद्भासितः शेषः शेषवसादिव क्षणमसौ क्रोडे निलीनानन । [। ७ ॥] तस्मादजायत निजायतबाहुवल्लिबद्धावरुद्धनवराज्यगजो नरेन्द्र[ः ।]
[8] सांद्रामृतद्रवमुचां प्रभवो गवां यो गोविन्दचन्द्र इति चन्द्र इवाम्बुरावेः [॥ ८ ॥] न कथमप्यलभंत रणक्ष्मांस्तिसृषु दिक्षु गजानथ वज्रिणः [।] ककुभिः पभ्रमुरभ्रमुव-
[9] ल्लभप्रतिभटा इव यस्य घटागजाः [॥ ९ ॥] सोयं समस्तराजचक्रसंसेवितचर[ण]ः परम-भट्टारकमहाराजाधिराजपरमेश्वरपरममाहेश्वरनिजभुजोपार्ज्जितश्री-

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* From the original plate.

L. 1. Read संरम्भः ; आसीदशीतद्युतिवंशजातक्ष्मा० ।
L. 2. Read व्यापारितं ।
L. 3. Read नयैकरसिकः ; विध्वस्तोद्धतवीरयोधतिमिरः ; ०शमिताशेष० ।
L. 4. Read काशिकुशिकोत्तरकोशलेन्द्र० ; ०मनिशं ।
L. 5. Read शतशस्तुलाभिः; ०कलशोल्लसितैः; the sign after पयोभिः superfluous.
L. 6. Read कलिरजः ; ०भ्रश्यन्मही० ।
L. 7. Read शेषवशादिव ; निलीनाननः ; ०बाहुवल्लिबन्धावरुद्धनवराज्यगजो नरेन्द्रः ।
L. 8. Read इवाम्बुराशेः ; रणक्षमांस्तिसृषु ; ककुभि बभ्रमुर० ।
L. 9. Read ०महाराजाधिराज० ।

[10] कन्यकुञ्जाधिपत्यश्रीचंद्रदेवपादानुध्यातपरमभट्टारकमहाराजाधिर[ा]जपरमेश्वरपरममा-
हेश्वरश्रीमदनपालदेवपादानुध्यातपरमभट्टारकमहारा-

[11] जाधिराजपरमेश्वरपरममाहेश्वराश्वपतिगजपतिनरपतिराजत्रयाधिपतिविविधविद्यावि-
चारवाचस्पतिश्रीमद्गोविन्द[चन्द्र]देवो विजयी ॥ पुरोहप-

[12] मलायां । जरगामग्रामनिवासिनो निखिलजनपदानुपगतानपि च राजराज्ञीयुवराज-
मंत्रिपुरोहितप्रतीहारसेनापतिभांडा[ग]ारिकाक्षपटलिकभिषग्नै-

[13] मित्तिकान्तःपुरिकदूतकरितुरगपत्तनाकरस्थानगोकुलाधिकारिपुरुषांश्च समज्ञापयत्यादि-
सति बोधयति च यथा [।] विदितमस्तु भवतां यथोपरिलिखित-

[14] ग्रामः सजलस्थल सलोहलवणाकर समत्स्याकर सपर्णाकर सगर्त्तोषर समधूकचूत-
वनविटपवाटिकातृणयूतिगोचरपर्य्यन्तः सोर्ध्वाद्धश्चतुरा[घाट]विशुद्ध स-

[15] सीमापर्य्यन्त पंचासीत्यधिकैकादससतसंवत्सरेषु चैत्रे मासि शुक्लपक्षे पौर्णमास्यां तिथौ
शुक्रदिने अङ्केपि संवत् ११८५ चैत्रसुदि १५ शुक्रे [॥ अद्येह] श्रीमद्वारा-

[16] णस्यां । मन्वादौ । गंगायां स्नात्वा विधिवत्देवमनुमनुजभूतपितृगणांस्तर्पयित्वा तिमिरपटलं
पाटनपटमहसमुष्णरोचिषमुपस्थायौषधिप[तिशकलशेख-]

[17] रं समभ्यर्च्य त्रिभुवनत्रातुर्व्वासुदेवस्य पूजा विधाय प्रचुरपयेसेन हविषा हविर्भुजं हुत्वा
मातापित्रोरात्मनश्च पुण्ययशोभिविद्धये गोक[र्णकुशलता]पू-

[18] तकरतलोदकपूर्व्वमस्माभिः मौनसगोत्राय । यात्रेतस । भार्गववैतहव्यत्रिप्रवराय । पंडितश्री-
महिपतिपौत्राय पंडितश्रीनरपतिपुत्राय । पंडित[श्रीभू]पति-

[19] सर्म्मणे ब्राह्मणाय आचंद्रार्कं यावत् सासनीकृत्य प्रदत्तो मत्वा यथादीयमानभागभोगकर-
प्रवणिकरतुरुष्कदण्डप्रभृतिसर्व्वादायानाज्ञावि[धेयीभूय दा-]

[20] स्याथ ॥ छ ॥ भवन्ति चात्र स्लोकाः [॥] भूमि यः प्रतिगृह्णाति यश्च भूमि प्रयच्छति [।]
उभौ तौ पुण्यकर्म्माणौ नियतं स्वर्गगामिनौ ॥ [१० ॥] संखं भद्रासनं छत्रं वराश्वा

L. 10. Read कन्यकुब्जा॰ ।

L. 11. The signs after विजयी are superfluous.

L. 12. Read मलायां जरग्रामनिवासिनो निखिल॰ ; ॰भिषङ्नै- ।

L. 13. Read समाज्ञापयत्यादिशति ; ॰लिखित॰ ।

L. 14. Read सजलस्थलः सलोहलवणाकरः समत्स्याकरः सपर्णाकर सगर्त्तोषरः ; सोर्ध्वाधश्चतुराघाटविशुद्धः स- ।

L. 15. Read सीमापर्य्यन्तः पञ्चाशीत्यधिकैकादशशतसंवत्सरेषु ; शुक्लपक्षे पौर्णमास्यां तिथौ शुक्रदिनेऽङ्केपि ; शुक्र- ।

L. 16. Read णस्यां सङ्क्रान्तौ गङ्गायां ; विधिवद्देवमुनिमनुज॰ ।

L. 17. Read पूजां ; प्रचुरपायसेन ।

L. 18. Read ॰पूर्वमस्माभिर्मौनेयगोत्राय गाधेयभार्गववैतहव्यत्रिप्रवराय पण्डितश्रीमहीपतिपौत्राय ।

L. 19. Read शर्मणे ब्राह्मणायाचन्द्रार्कं यावच्छासनीकृत्य ।

L. 20. Read श्लोकाः, भूमिं यः प्रतिगृह्णाति, भूमिं ; नियतं स्वर्ग॰ ; शङ्खं ।

[21] वरवारणाः [।] भूमिदानस्य चिह्नानि फलमेतत्पुरंदरः ।[। ११ ॥] बहुभिर्व्वसुधा भुक्ता राजभिः सगरादिभि र्येस्य यस्य यदा भूमिस्तस्य तस्य तदा फल ॥ [१२ ॥] ग्रामे-

[22] कां सुवर्णमेक च भूमेरप्येकमंगुलं [।] हरंनरकमाप्नोति यावदाभूतसंप्लवम् ॥ [१२ ॥] षष्टिं वर्षसहस्राणि स्वर्गे वसति भूमिदः [।] आच्छेता चानुमन्ता च

[23] तान्येव नरके वसेत् ॥ [१४ ॥] स्वदत्तां परदत्तां वा यो हरेत्वसुंधरां [।] स विष्ठायां कृमिर्भूत्वा पितृभिः सह मज्जति ॥ [१५ ॥] सर्व्वानेतान् भाविन पार्थिवेन्द्रान्

[24] भूयो भूयो जाचते रामभद्रः [।] सामान्योयं धर्म्मसेतुर्न्नृपाणां काले काले पालनीयो भवद्भिः ॥ [१६ ॥] यानीहि दत्तानि पुरा नरेन्द्रैर्दानानि धर्म्मार्थयसस्क-

[25] रा[णि ।] निर्म्माल्यवान्तप्रतिमानि [तानि] को नाम साधु पुनराददीतः ॥ [१७ ॥] तडागानां सहस्रेणाश्वमेधशतेन च [।] गवां कोटिप्रदानेन भूमिहर्त्ता न शुध्य·

[26] ति ॥ [१८ ॥] [लिखि]तं ताम्रपट्टकं धर्म्मलेखिठक्कुरश्रीश्रीचंद्रेणेति ॥

Translation.

Oṃ! May it be well!—(verses 1 to 9 = 1 to 9 of inscription, No. I.)

(l. 9.) He it is who has homage rendered to his feet by the circle of all rájas; he, the most worshipful, the supreme king of mahárájas, the supreme lord, the devout worshipper of Máheśvara, the lord over the three rájas, (*viz.*), the lord of horses, the lord of elephants, and the lord of men, (like) Bṛihaspati investigating the various sciences, the illustrious *Govindachandra Deva*,—who meditates on the feet of the most worshipful, the supreme king of mahárájas, the supreme lord, the devout worshipper of Máheśvara, the illustrious *Madanapála*,—who meditated on the feet of the most worshipful, the supreme king of mahárájas, the supreme lord, the devout worshipper of Máheśvara, the illustrious *Chandradeva* who by his own arms had acquired the sovereignty over Kanyákubja:—

(l. 12.) He, the victorious, commends, informs, and decrees to all the people assembled, resident at the village of *Jara* in the *Puroha* district, and also to the rájas, rájñís, yuvarájas, counsellors, chaplains, warders of the gate, commanders of troops, treasurers, keepers of records, physicians, astrologers, superintendents of gynecaeums, messengers, and to the officers having authority as regards elephants, horses, towns, mines, districts, cattle-stations, as follows:—

L. 21. Read ◦पुरन्दर ; सगराद्भिः । यस्य ; फलम् ।
L. 22. Read सुवर्णमेकं च भूमेरप्यङ्गुलं । हरन्नरकमा◦ ; स्वर्गे ; आच्छेत्ता ।
L. 23. Read हरेत वसुन्धरां ; सर्वानेतान्भाविनः ।
L. 24. Read याचते ; यानीह ; ◦यशस्क- ।
L. 25. Read साधुः पुनराददीत ; ◦ण्यश्वमेधशतेन ; शुध्य- ।
L. 26. Read चेदं ताम्रपट्टकं ।

(l. 14.) Be it known to you that,—after having bathed here today in the Ganges, at the illustrious Váráṇasí (Benares), on the occasion of the sun's entrance into another zodiacal sign after midnight, after having duly satisfied the divinities, saints, men, beings, and the groups of ancestors, after having worshipped the sun whose splendour is potent in rending the veil of darkness, after having praised him whose crest is a portion of the moon (S'iva), after having performed adoration of Vásudeva (Kṛishṇa), the protector of the three worlds, after having sacrificed to fire (Agni) an oblation of clarified butter with abundant milk, rice and sugar,—we have, in order to increase the (spiritual) merit and the fame of our parents and ourself, on Friday the 15th lunar day of the bright half of Chaitra in the eleven-hundred-and eighty-fifth (Vikrama) Saṃvat year,—in figures too, on Friday the 15th Chaitra-sudi 1185,—given the above-written village with its water and dry land, with its mines of iron and salt, with its fisheries, with its betel leaves' with its ravines and saline wastes, with and including its groves of *madhúka* and mango trees, enclosed gardens, bushes, grass and pasture land, with what is above and below, defined as to its four abuttals, up to its proper boundaries, to the Bráhman, the *Paṇḍiṭa*, the illustrious *Bhúpatiśarmá*, son of the Paṇḍita, the illustrious *Narapati*, grandson of the Paṇḍita, the illustrious *Mahípati* of the *Mauneya gotra* (and) whose three *pravaras* are Gádheya (Viśvámitra), Bhárgava (Chyavana), and Vaitahavya (Aruṇa),—(confirming our gift) with (the pouring out) from the palm of our hand, shaped like a cow's ear, (of) water purified with kuśa-grass (and) ordaining (that it shall be his) as long as moon and sun (endure). Aware (of this), you, being ready to obey (our) commands, will make over to him the due share of the produce, the money-rent, the taxes on aromatic reeds, and so forth.

(l. 20.) And on this (subject) there are (the following) verses: (v. 10.) Both, he who accepts land and he who grants it, are equally meritorious, and they go certainly to heaven.

(v. 11.) A conch-shell, a throne, an umbrella, choice horses, and excellent elephants, oh Purandara (Indra), are the royal insignia which constitute the reward of giving away land.

(v. 12.) This earth has been enjoyed by many kings, including Sagara and others. To whomsoever belongs the earth for the time being, he enjoys the fruit (of such gifts).

(v. 13.) He who robs a cow, a gold coin, or a finger's breadth of land, dwells in hell until the dissolution of the universe.

(v. 14.) The donor of land dwells in heaven for the space of sixty thousand years; the resumer, and the abetter thereof, are doomed to abide in hell for a like period.

(v. 15.) Whoever robs land whether given by himself or by others, becoming a maggot, sinks with his parents into ordure.

(v. 16.) Rámabhadra repeatedly intreats all present and future lords of earth (to bear in mind) that this bridge of virtue, (*i. e.*, the granting of lands) is common to all sovereigns, and should be preserved by you at all times.*

(v. 17.) All the gifts of former kings are productive of virtue, wealth and fame,—how can he, who claims the name of goodness, resume them but as emblems of vomited food.†

(v. 18.) The alienator of land-grants cannot expiate his crime even (by dedicating to public use) a thousand tanks, by (performing) a hundred horse-sacrifices, and by giving away in charity ten millions of cattle.

(l. 26.) And this copper-plate grant has been written by the expert *káyastha*, the *Ṭhakkura*, the illustrious (and) venerable *Chandra.*

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* Metre: S'álinî.

† Metre: Vasantatilaká.

JOURNAL

OF THE

ASIATIC SOCIETY OF BENGAL.

Part I.—HISTORY, LITERATURE, &c.

No. III.—1887.

"Plate X will be published with the next number."

language differs more or less in every *pargana.*

The exceedingly local character of the collection will not fail to be noticed.

A few notes have been interspersed in the hope that they will interest some readers. The romanizing is on the plan followed in the "Dictionary of Kashmírí Proverbs and Sayings."

The Roman-Kashmírí alphabet.

A a pronounced as *a* in wom*a*n.
Á á pronounced as *a* in *a*rt.
Ai ai pronounced as *ai* in *ai*sle.
Au au pronounced as *ou* in *ou*r.
B b pronounced as *b* in *b*ut.
Ch ch pronounced as *ch* in *ch*urch.
D d pronounced as *d* in *d*ew,—the point of the tongue is pressed on the upper fore-teeth.
Ḍ ḍ pronounced as *d* in ba*d*,—the point of the tongue is struck back on the palate.
E e pronounced as *e* in th*e*re.
Ĕ ĕ pronounced as *e* in pet.
F f pronounced as *f* in *f*ind—the English *f* is only sounded (and then very badly), in the middle or at the end of

a word. If it occurs at the commencement of a word it is most distinctly and invariably turned into *ph*.

G g pronounced as *g* in *go*. The Arabic letter g͟hain (g͟h) with its peculiar guttural sound is seldom heard in pure Kashmírí.

H h pronounced as *h* in *h*ouse.

I i is a kind of half *i*. I hear that there is something analogous to this to be found in Russian and is written in that language as *j*.

Í í pronounced as *i* in pol*i*ce.

J j pronounced as *j* in *j*ust.

K k pronounced as *k* in *k*ettle.

K͟h k͟h pronounced as *ch* in the Scotch and Irish lo*ch* or the final *ch* of the German scha*ch* and bu*ch*. This k͟h (k͟he) is generally ignored by the true Kashmírí.

L l pronounced as *l* in *l*ane.

M m pronounced as *m* in *m*an.

N n pronounced as *n* in *n*oon.

Ṇ ṇ pronounced as *n* in the French sa*n*s, bo*n*.

O o pronounced as *o* in n*o*.

P p pronounced as *p* in *p*aint.

Ph ph pronounced similar to *ph* in *ph*legm.

R r pronounced as *r* in *r*an. A Scotchman's *r* is perhaps not met with in pure Kashmírí.

S s pronounced as *s* in *s*in.

Sh sh pronounced as *sh* in *sh*ine.

T t pronounced as *t* in *t*ake—the point of the tongue is pressed on the upper fore-teeth.

Ṭ ṭ pronounced as *t* in *t*ub—the point of the tongue is pressed back on the palate.

T͟s *t͟s* pronounced as *ts* in ge*ts*.

U u pronounced as *o* in t*o*p.

Ú ú pronounced as *u* in r*u*le.

V } v w both pronounced like something between the English *v* and *w*.
W }

Y y pronounced as *y* in *y*ear.

Z z pronounced as *z* in *z*eal.

Chh, gh, kh, ph, th, ṭh, and tsh are respectively the aspirates of ch, g, k, p, t, ṭ, and t͟s, and are pronounced as one letter.

In addition to the above there is a sound which is something like a very short *i*; it is frequently the sign of the instrumental case. In the Roman character this sound will be represented by the simple letter *i*; and in order that this *i* may always appear the final *he* (*há, e muk͟htafí*) has always been written.

1, *Akhá chhĕm wuḍahnaní;*
Yad kaḍit Yamrázaní.
Wustád khutus wulahmaní,
Pur karit karanas chhĕní.

I have a bare-headed woman,
With a (lit. putting out her) stomach like Rájá Yam,

Her master climbed over her (or on her) like a thief,
And emptied her stomach.

Ans. *Kondah*, a brick-kiln.

Yam, *Yama*, the regent of the realms of death.

2, *Damah rust kus ásih ?*
Thamah rust kus ásih ?
What is that without a covering ?
What is that without a pillar, (*i. e.* support) ?

Ans. *Daryá tah ásmán*, the river and the sky.

3, *Aḍ t̲s̲uṭ tah machámah khos.*
Half a bread and a bowl of *machámah.*

Ans. *Zún tah sitárah*, the (half) moon and stars.

Machámah, a dish eaten by Kashmírís consisting of rice, vegetables, raisins, colouring matter, and sugar.

Khos, a cup shaped like a bowl, either of copper, iron, or brass. The Musalmán's *khos* is much larger than the Hindú's. The latter does not eat rice out of this vessel.

4, *Mámas chánis nukrih raz.*
A rope on your uncle's nose.

Ans. *Tol*, a contrivance consisting of a long wooden pole, so placed upon another fixed perpendicular pole, that one end shall be nearly equal in weight to the other end, with a vessel full of water. It is employed in raising water out of a stream for irrigation.

The only reason I can find for using the word 'uncle' here or in No. 81, or the word 'aunt' as in Nos. 14, 22, is that to quote one's parents in such a connection would be thought disrespectful.

5, *Guḍah khat̲s̲ gormáj t̲s̲or lachh hĕt.*
Patah khut Malah Sharák tul tah tarák hĕt.
First rose up the *gurú's* wife with four *lakhs* (of bodies).
Then arose Sharák the Mullá and took and lifted up his axe (at her).

Ans. *Zún sitárah tah áftáb* , the moon, the stars, and the sun.

Sharák is a very uncommon name in the valley. In olden days it was more popular.

6, *Shistravis mahanivis gásuv phĕran.*
A grass *phĕran* to an iron man.

Ans. *Yindartul tah kanarih*, the part of the spinning-wheel corresponding to the distaff—and that on which the little wheel of the spinning-wheel rests.

The *kanarih* rests on a little cushion of plaited grass.

Phĕran (piráhan, Pers.) a long robe resembling a very full night-gown, worn by Kashmírís.

7, *Sunah sandis ḍabas, rupah sund ṭhán,*
Yus tath wáṭe, suí pahalwán.
A golden box with a silver lid;
He who can shut it is a brave fellow.
Ans. *Zamín tah ásmán,* the earth and sky.

8, *Káv aus kruhun tah wáwah suĕt ḍale; tulah chhum lut tai mulah chhum gub.*

The crow was black and it will shake with the wind; its weight is light and its price is heavy.

Ans. *Gund,* a tuft of heron's feathers with which the bridegroom is adorned for the wedding. As many as three hundred feathers are sometimes worn, and as much as one rupee has been given for a feather. Rich people keep them hanging from the ceilings of their rooms from fear of the cat; but poor people can only afford to hire them.

9, *Tílahwán nĕchivis sunah sund ṭyuk.*
A golden *ṭíká* on (the face of) an oilman's son.
Ans. *Dazawun ts̤ong (díwá, Sansk.),* a lighted lamp.

10, *Phát Máj bihit tah Phati kúr nats̤án.*
Mother Phát is sitting down, and the daughter Phatah is dancing.

Ans. *Kuí tah don* the pot in which the butter is churned and the stick with which it is churned. Cf. Nos. 30, 34.

The Kashmírí has a very ingenious way of making butter. When the milk is ready for churning, it is poured into a big vessel, in the cover of which there is a hole. In this hole a stick is placed. The part of the stick which is inside the vessel is thick, and the part outside the cover is thin. To this thin part a piece of string is attached, and the ends of it the man, or the woman, hold in their hands, and putting one foot upon the cover to steady it, twirl about the stick with the string, first pulling one end then the other till the butter is prepared. A slightly different custom prevails in India.

Phát and *Phatah* are Kashmírí proper names.

11, *Das, das karawun dáí chhukho;*
Bĕbih khos tah mĕhmán chhukho;
Patakini yaṭ tah král chhukho;
Athih lúr tah piyádah chhukho;
Bronṭhkani basam tah saniyás chhukho;

Shĕstrov phĕran tah khár chhukho ;
Tah garah garah pádsháh chhukho ;
Making a noise, you are a god ;
A cup in your lap, you are a guest ;
A basket on your back, you are a potter ;
A stick in your hand, you are a messenger ;
Ashes before you, you are a *sannyásí ;*
An iron garment over you, you are a blacksmith ;
You are a king in every house.

Ans. *Graṭṭah,* a handmill.

Dái is esteemed as a god in the house and sometimes worshipped. Cf. *Panjáb Notes and Queries,* Vol. III, 84.

The *cup in the lap,* i. e., the hole in the upper mill-stone (called *auhuk*) in which the grain is placed.

Yaṭ a cone-shaped basket used by potters for carrying their wares to the market. The hole into which the handle of the upper mill-stone fits *(gud)* is supposed to be like this.

A *stick in your hand,* refers to this handle, called *dárun* in Kashmírí.

The *ashes* of course refer to the dust that gathers before the mill-stone.

The *garment of iron,* i. e., the upper mill-stone.

12, *Sará ausum ; sará rusum ; sarav khutah buḍ ;*
Manz wátis nah to phul auḍ.
I've got a tank ; I've got a tank ; it is greater than other tanks ;
And yet it will not contain half a sesame flower.

Ans. *Bab,* a nipple, an udder.

Tel phul is the *Sesamum orientale.*

This is also a proverb and quoted concerning a big, fat, man—with no brains.

13, *Herih wutsh hakar bunah raṭ sháṭhan.*

A log of wood descended from above and was stopped (lit. seized) by the sand.

Ans. *Kangú,* a (man's) comb, (stopped by tangled hair).

14, *Saras andar mámani piyáyih ;*
Wadavih gás, tsup hĕnih áyih.
Aunt gave birth to a child in the lake ;
We went to congratulate her and she came to bite us.

Ans. *Pambah lukhar,* the nut-case of the *Euryale ferox,* an aquatic plant, the seeds of which are eaten by the natives of the valley. Its broad, round, leaf lies on the water like that of the lotus, its upper surface being in no way remarkable, whilst below it is covered with numerous, hard, sharp, and hooked *spicula*, with which the natives often prick themselves, when gathering the seeds.

Mámani, mother's brother's wife.

15, *Treh nanih; treh khanih; treh sávěnih.*

Three are naked; three are coverlets; three are *parda-nishín* women.

ANS. *Kong-posh*, a saffron flower.

16, *Phulmut guláb tah t̲s̲aṭán nah kaṇh,*

The rose has bloomed and nobody cuts it.

ANS. (Hindús) *Siriyih*, } The Sun.
(Musalmáns) *Aftáb*, }

17, *Múmut murdah tah wadán nah kaṇh.*

The man has died, and nobody weeps.

ANS. *Lar*, a house.

A house is here compared to a man. It is said to be dead when its inhabitants are asleep or absent.

The idiom is peculiar—literally it is 'a dead man has died.'

18, *Watharamut watharun shungán nah kaṇh.*

The bed has been spread and nobody lies (or sleeps) on it.

ANS. *Tulah-katur*, ice on the surface of water.

19, *Dar gayá, darbár gayá;*
Áb ḍíshit mar gayá.
It went to court, it went to court;
(And) on seeing the water it died.

ANS. *Kágaz* (*Kág̲h̲az, Pers.*) paper.

An impromptu riddle on seeing a court *munshí* drop his papers into the river as he crossed over the bridge to the court.

20, *Wahá ḍúris mahah wawem;*
Kálah wuchham, pagah nah kunih.
I sowed *mahá* in a field of air;
Yesterday I saw it, but to-morrow it is nowhere.

ANS. *Tárakdár rát*, a starry night.

Mahá (Hindúst. *másh*), *Phaseolus max* or *radiatus*. *Mahah* is the objective form.

21, *Laṭih rust mewah kyah?*

What fruit is it without a tail?

ANS. *Ṭhúl tah nún*, egg and salt.

22, *Aḍ gaz mámanih ḍoḍ gaz púṯ̲s̲.*

A veil one and a half yard long for my aunt who is only half a yard high.

Ans. *Suṯ̲s̲an tah panahdáv*, needle and thread.

Púṯ̲s̲, is the long piece of cotton cloth thrown over the head and allowed to hang down the back of the Kashmírí woman.

23, *Bar dit k̲h̲ar naṯ̲s̲án.*

Shutting the door the ass dances.

Ans. *Graṭṭah*, a mill.

Asses, I believe, run about and kick up their heels when they bray. The noise of the mill in motion is supposed to resemble them.

This is a proverb also, and is frequently quoted concerning the man who is full of words in his house, while outside he does nothing.

24, *Darak̲h̲tí jánwárá ; darak̲h̲tas chhuh nah bihán*
Bachih kashí beshumár ; pháh chhuk nah zah diuán.
It is a tree-bird (*i. e.*, has wings) ; it does not sit on a tree ;
It has young without number ; it never hatches them.

Ans. *Gáḍ*, a fish.

25, *Kuṭhkuṭháliye, kuṭ khaṯ̲s̲áyikhai ; muk̲h̲tah yaḍ barthai, mugal ṭúpi diṯ̲s̲thai.*

O woman, you ascended to the second storey, filled your stomach with pearls, and wore a hat like a Mug̲h̲al.

Ans. *Dánas pĕth dekchih, (degchí, Pers.)*, a saucepan (of rice) on the hearth.

Kuṭhkuṭhálĕni, ancient Kashmírí for a very respectable woman, who generally sat in the *kuṭh* or *kuṭ*.

Kuṭ, the floor or floors between the ground-floor and the topmost floor of the house.

The bubbling boiling rice resembles pearls.

Mugal ṭúpi = *kuláh-i-mug̲h̲al.*

26, *Dár dit hár naṯ̲s̲án.*

Shutting the window the starling dances.

Ans. *Yindar*, spinning-wheel.

27, *Akahlad malare phakahlad poni ;*
Yĕtih byuṭh díndár, tatih byuṭh woni.
Stinking water in a foul water-pot ;
Where the religious man sits, there sits the *baniyá.*

Ans. *Gurguri*, a smoking pipe of brass or copper (the *huqqa).*

Malar, a big earthen water vessel holding between twenty-five and thirty *sers* of water.

Poni, water. This word is used only by the Hindús. The Musalmáns invariably say *áb*.

Woni, the shop-keeper is regarded by the people as the incarnation of all evil, and is therefore quoted here as the opposite of the ***díndár*** man. Kashmírís have a saying:—*Woni chhuí poni kisarih tali*, the shopkeeper is like water covered over with rice-chaff.

28, *Ḍulámih, ḍulámih mahanivyo, nar tih chhai nah zang,*
Máz chon khanḍahákar, aḍij cháni rang.
O round man without arms or legs,
Your flesh is like sweetmeat, your bones are coloured.

ANS. *Kharbuz (Pers. k͟harbuza)*, a musk melon, which is grown in great quantities all over the valley. It ripens about August.

29, *Sunah sandis tálawas, rupah sanzah lanje.*
Árifan dup Zárifas "yimah kami ganje ?"
Silver branches stretched across (lit. to a) a golden ceiling.
Árif said to Zárif, "Who tied them ?"

ANS. *Zalarih sund zál*, a spider's web.

Arif and *Zárif* are corruptions of the Arabic *Árif* (wise) and *Zaríf* (witty). The names are most uncommon in the valley. I only know of Árif Bánd (Hindúst. *Bháṇḍ*) an actor.

30, *Yĕdrih manz wáv kas ?*
Shan rĕtan ráj kas ?
Who has the wind in the winter ?
Who has the rule for six months only ?

ANS. *Kul*, a tree.

Trees in Kashmir flourish for six months only. The remaining half of the year they are bare and are supposed to feel the wind.

31, *Wanai záv, wanai piyáv ;*
Wanai wasit, nat͟sanih dráv.
It was born in the jungle ; it gave birth in the jungle ;
On coming from the jungle, it went out to dance.

ANS. *Don*, the stick with which the butter is churned. *Vide ante* Nos. 10, 81.

32, *Wuzul piyádah harámzádah.*
A rascally red messenger.

ANS. *Marat͟sawángun*, red pepper.

This pepper grows in the valley, and is a very favourite spice with the people. It is compared with the *piyádah*, because it sometimes makes people "smart for it." *Piyádahs* are those who "look up" the Government debtors now and again.

Harámzádah is here translated as a term of abuse as intended.

33, *Tsuh zungú, tsudaháh zungú, uk zungú kulis pĕṭh;*
Tasund máz pádsháhan mungú. Timan tran chhuh kunuí náv.
Of four feet, of fourteen feet, of one foot up in a tree;
Its flesh is liked by kings. There's only one name to the three.

ANS. *Khar* an ass, *khar* an insect, and *khar* (or more properly *kharbuzah*) a musk melon.

34, *Saras andar paliyárih haná.*
A little hedge in (or round) the lake.
ANS. *Achharwál,* eyelash.

The eye is often likened to ponds and lakes. Cf. Canticles vii, 4. The simile well sets forth the appearance of a large, clear liquid.

35, *Saras andar kájiwaṭah haná.*
A little pestle in the lake.
ANS. *Lár,* a cucumber.

An immense number of cucumbers, melons, and tomatoes are raised on the gardens that float on the lake near Srínagar. For a good description of these floating gardens cf. *Moorcroft's Travels.*

36, *Saras andar wukhlah haná.*
A little mortar in the lake.
ANS. *Hĕndawĕnd,* a water-melon.

37, *Saras andar lorih haná.*
A little stick in the lake.
ANS. *Nadur,* the stalk of the lotus *(Nilumbium speciosum).*

It grows abundantly in the extensive lakes of Kashmír. It is about ten inches long and one and a half inch in diameter.

38, *Mongah trakas duchih kátsah?*
Gámah shahrah dorih kátsah?
Anḍharishi korih kátsah?
How many half-grains are there in one *trak* of *mong?*
How many streets are there in the villages and cities?
How many virgins are there?
ANS. *Sitárah,* the stars (i. e., they cannot be numbered).

Mong, Phaseolus max or *Radiatus.*

Trak, vide post No. 88.

Dúr is a street without shops.

39, *Dayih sans Dayiygat ;*
Zalari sanz chhĕh záj ;
Májih sĕwán gubur tah
Gubaras zĕwán máj.
(It is) the work of God ;
It is a spider's web ;
The mother gives birth to a son,
And the son gives birth to a mother.

Ans. *Al,* a pumpkin.

The pumpkin is a very favourite culinary vegetable with the Kashmírís and all orientals. Its stems twine and intertwine all over the place where it grows. *Vide cucurbitacæ* in any botanical dictionary for a full description.

40, *Saras andar nárah-ṭáki hanź.*
A little plate of fire in the lake.

Ans. *Pamposh,* the lotus.

41, *Wuzalis gánas chhati kachih-púti.*
White lambs in a stall.

Ans. *Ásas andar dand,* the teeth in the mouth.

Gán is the underground floor of the house, where the kine, etc. are sometimes housed.

Kachih-pút is old Kashmírí, and almost obsolete now,—the present words for lambs being *chirrakaṭ* and *chirr.*

42, *Lam tal tham t̲s̲or.*
Four pillars under a heap (of earth).

Ans. *Gov hanzah babah t̲s̲or,* a cow's four teats. Cf. No. 78.

43, *Sari, sari áyĕkhai, Padmání, raṭit dyutmai dab.*
O Padmán, you came by way of the lake, and I laid hold of you and threw you down.

Ans. *Khĕni kaḍani,* to blow one's nose (native fashion). *Vide* Nos. 63 and 138.

44, *Chíst án jánwar* (or jánwár) *ḍijih ḍijah ;*
Andar chhus máz tai nĕbar aḍijah ?
What is that animal (that can be tossed) up and down ;
Inside it is flesh and outside bones ?

Ans. *Ṭhúl,* an egg.

45, *Máji chhak ránṭas tah shuri dívatáh.*
The mother is a devil and the children are gods.

Ans. *Guláb posh,* a rose bush (in bloom).

46, *Laṭih mikráz kas ?*
Haṭih mukhtahár kas ?
Shan rĕtan ráj kas ?
Who has a tail (like) a pair of scissors ?
Who has a necklace on her throat ?
Who has rule for six months (only) ?
Ans. *Katij*, a swallow.

The swallow generally arrives in the valley about the beginning of April and remains for six months. Its throat is a deep reddish-brown and has a ring of dark blue round it. The lateral tail feathers are very long and give a remarkable, forked appearance to the tail. Cf. No. 54.

47, *Uṭhin lad májih záyih shírín dáni kúr ;*
Shírín dáni májih záyih uṭhin lad kúr ;
A sweet girl was born to a twisted (or crooked) mother ;
A twisted (or crooked) girl was born to a sweet mother.
Ans. *Dachhahráṇṭh*, the vine. Cf. No. 39.

48, *Tsor zangah chhĕs tah pakán chhuh nah ;*
Zah kan chhis tah buzán chhuh nah ;
Batah chhis diwán tah khĕwán chhuh nah.
It has four legs, and does not walk ;
It has two ears, and does not hear ;
We give it food, and it does not eat.
Ans. *Ṭaṭhul* (or *Ṭaṭhuj*), a large wooden dish out of which Musalmáns eat. It stands on four little wooden legs. Its two handles are the ears.

49, *Sah pakán báli,*
Trah tshanit náli.
A tiger walks on the bank (of the river).
And thirty (people) are round (or clinging on to) his neck.
Ans. *Bahats*, a barge (towed up the river).

50, *Shamáas pĕth uk-tsurah ;*
Uk-tsáris pĕth trah-tsurah ;
Trah-tsáris pĕth kanḍi-záláh ;
Kanḍi-zálas pĕth Khojih Bábáh ;
A fire-place on a candlestick ;
On this fire-place (another fire-place with) three holes ;
On this three-hole (fire-place is) a hedge of thorns.
On this hedge Khája Bábá.

Ans. *A'sas pĕṭh nast tah achh zah; tath pĕṭh bumbah; tah tamih pĕṭh kun dastár.* (The body is the candlestick, over which is the mouth); over the mouth (are) the nose and two eyes; over them the eyebrows; and on top of that the turban.

Kashmírí fire-places are generally made of plastered mud with one, two, four, or six holes on the top to receive the cooking vessels.

51, *Yorah gat̲s̲hán dawán dawán;*
Torah yiwán lut lut.
Going from here running running;
Coming from there slowly.
Ans. *Nĕbar nerun,* to go out, *(hájat-i-bashari).*

52, *Hakan hukan; dahih zangih pakan; trĕh pon; tah shĕh kan.*

(It makes the sound of) *hakan hukan;* walks with ten feet; (has) three fundaments; and six ears.

Ans. *Dándah júri tah wáyanwol,* a yoke of oxen and their driver.

The plough's creaking, as it passes through the soil, is supposed to say *hakan hukan.*

53, *Herih wuth jandah sháh jandah tráwit.*
The mendicant descended from above, leaving his cloak behind him.
Ans. *Ḍún,* a walnut (stripped of its skin.)
Any one who has seen a ripe walnut fall will understand this riddle.

54, *Sarah khat̲s̲ak sar málah ganḍit;*
Dunyá áyak t̲s̲hanḍit kyah;
Garih dráyak garawol banit;
Kálachan lájtham panḍitbái.
You came up from the lake wearing a necklace on (your) neck;
You came wandering (all over) the world;
You left your house as the owner:
In the evening you tried to make me think (or pretended) you were a *panḍitání.*
Ans. *Katij,* a swallow.
Vide ante No. 46.

55, *Kirkichih ḍabas nábad wuras;*
Tamich súrat chhĕh ábas pĕṭh.
I will put sugar (instead of grain) under the grain crusher;
Its shape is in the water.
Ans. *Ainah (Pers. áina)* a mirror.
I cannot explain this riddle, nor any one also whom I have asked.

56, *Lará lazam, lará lazam satimis ásmánas pĕṭh. Nah dupum dusilas, nah dupum chhánas. Pánai karimas hatahbudi k̲h̲ánah.*

I built a house, I built a house up in the seventh heaven. I spoke not to a mason, I spoke not to a carpenter. I built it myself (and all the) hundreds of rooms in it.

ANS. *Mánchh gan*, a bee-hive. Cf. No. 60.

Satyum ásmán, the seventh heaven, *(falaku-l-aflák)* the empyrean heaven.

Muhammadans undoubtedly get their tradition of seven heavens from the Talmud. Cf. *Hughes' Notes on Muhammadanism*, pp. 91-95.

The bees generally build their houses high up in the hollows of trees and rocks.

57, *T̲s̲har chham tah bar chham;*
Rájih sandih bágh chham;
Dushálah walit chham;
Nav lachh mukhtah gandit chham.
I have (something which) is empty, and I have (something which) is full.
I have (something) in the rájá's garden,
I have (something that) wears a shawl,
And I have (something which) is adorned with nine *lakhs* of pearls.

ANS. *Makáyih waṭ*, Indian-corn.

Below are three variants of the same riddle—

Harí thí
Man bharí thí
Ghane motioṇ se jaṛí thí
Báhir maidan dhartí par dosálá oṛhe khaṛí thí.

ANS. *Khet makkí kí.*

Ját district, Eastern Jamná Canal, N. W. P.

Harí thí
Man bharí thí
Sawá lákh motí jaṛí thí,
Rájájí ke bágh meṇ, dushálá oṛhí khaṛí thí.

ANS. *Bhuttá* or *makkí*

Hindí riddle.

Harí thí, man bharí thí
Lákh motioṇ jáṛí thí,
Rájájí ke bágh meṇ jatán khiláṛí khaṛí thí.

ANS. *Chhalí.*

Panjábí.

Cf. *Punjab Notes and Queries*, Vol. I, 899, Vol. II, 626 and *Indian Notes and Queries*, Vol. IV, 68.

58, *Baṭh tali tsalán, laṭ tsaṭ gáv.*
A cow with its tail cut runs away under the bank.
Ans. *Náv*, a (Kashmírí) boat.

59, *Sheyih trah dárih tah sheyih trah bar chhis,*
Sheyih trah gaz bar panah chhus,
Rájas phirayo ryts wásaná,
Tájas pĕṭh sonah manah chhus.
It has thirty-six windows and thirty-six doors,
It is thirty-six yards in width.
It was a good thought of the Rájá, (lit. turned over a good thought).
On its crown is a maund of gold.

Ans. *Juma mashíd (yá baḍ mashíd)* the great mosque in Srínagar city which was commenced by Zainu' l ábadín and finished by Sháh Jahán. It is a very large four-sided building with an open square in the centre. There must be nearly one hundred windows in the place, while there are only four doors; and its width is not thirty-six yards any way—the north and south sides are about 20 yards wide, the east side is sixteen yards and the west 22 yards.

Wásaná is old Kashmírí, not used or generally known now-a-days. *Khiyál* is now used.

The gold on the crown refers to the gilding of the domes of the mosque.

60, *Larah lazam tarahdár;*
Nah unmas chhán tah nah unmas khár.
I built a splendid house;
I brought neither a carpenter nor a blacksmith (to help me in building it).

Ans. *Mánchh gan*, a bee-hive. Cf. No. 56.

61, *Alah, alah wáv kas?*
Bishtuk bayih kas?
Kánah kánah latah kas?
Who shakes with the wind?
Who fears *bishtah?*
Who receives kicks in his sides?
Ans. *Kul*, a tree—*bror*, a cat—and *lĕwan*, a spade.
Bishtah is an exclamation used to drive away cats.

62, *Akhá pakán tah thakán nah zah;*
Byákhá bihit tah wuthán nah zah;
Byákhá wudanih tah bihán nah zah.

One goes on and is never tired;
Another sits and never rises;
Another stands and never sits.

Ans. *Áb,* water—*zamín,* earth—and *ásmán (yá nab),* the firmament.

63, *Machih kaḍit múnih ṭhas.*

Taking it out of a large earthen jar and dashing it against the wall.

Ans. *Kheni kaḍani,* blowing the nose after the native fashion.

If sitting in his house, the ordinary poor Kashmírí will fling the snot against the wall. *Vide* Nos. 43 and 138.

64, *Kurih haná ásam; duhas ásam phírit thúrit yiwán, kálachan ásam baras tal bihán.*

I have a little girl, by day she wanders hither and thither, at night she sits down by my door.

Ans. *Lúr,* a staff.

65, *Herih kanĕn khushkah graṭṭah, huḳh tah audur melih tath;*
Tamí werih álam pherih, pĕṭhim t̲s̲akuj pherih nah zah.
Above is a dry mill, dry and wet will meet there;
For it the world will turn, (but) the upper mill-stone will never turn.

Ans. *Ás,* the mouth.

Its roof is the dry mill,—where dry and wet food meet. The world will turn before the upper jaw will move, *i. e.,* it will never move.

Werih, (for the sake of) is very ancient Kashmírí. *Khátirah* or *bápat* or *kyut* is now used.

66, *Sar hukh zih píṇt̲s̲káni muyih.*

The tank dried up and the *píṇt̲s̲káni* died.

Ans. *T̲s̲ong,* a lamp *(díwá* Sansk.); *píṇt̲s̲káni,* (Pers. *Ziwa.*).

All I know about the píṇt̲s̲káni is that it is a little bird with extremely small eyes.

67, *Shoni, shoni kranḍas,*
Akusuí zanḍas shurah sás.
(It makes the noise of) *shoni, shoni,* in a *khilta.*
To one plant there are sixteen thousand seeds.

Ans. *Ganhár,* the *Amaranthus anardana* and *Gangeticus.*

The pearl ashes of this wood are used by washermen for cleaning linen.

68, *Bálah pĕṭhah minyimar ush tráwán.*

A hind sheds tears from off a hill.

Ans. *Batah phydrun,* straining rice (out of a pot).

69, *Chízah handá chham; nah chham zánán apur tarit nah yapur.*

I have a little thing; it does not know how to go across or to come across.

Ans. *Paliyár*, a hedge.

70, *Wanas khase tabardár;*
Akih akih dage sású tsaṭe;
Wanas wále gaṭakár.
The woodcutter will go to the copse;
He will cut down a thousand trees with each stroke;
And will destroy the junglo.

Ans. *Náid*, a barber. *Vide* Nos. 112 and 129.

71, *Wanas kúṇs kyah?*

What is young in the jungle?

Ans. *Kanahguchh*, a mushroom of which large quantities are to be found in the valley.

Kúṇs, young in age, in height, and experience.

72, *Wanas zyuṭ kyah?*

What is old in the jungle?

Ans. *Duh*, smoke.

Zyuṭ old in age and stature, etc.

73, *Kaṇ kaṇ gáso, phírit áso.*

O rustling grass, I have returned with you.

Ans. *Pulahor*, a grass sandal, made from rice-straw (*Oryza sativa*).

The straw is first twisted into a rope, and then interwoven to make a sole, which is fastened on to the foot sandal-wise.

74, *Báyih dapiyo? bápathar dapiyo? aurathar dapiyo? karayo ho tah ho?*

Shall I call you brother? Shall I call you nephew? Shall I call you my husband's other wife's son? Shall I put you to sleep?

Ans. Once upon a time there was a king, who died and left his wife and son and daughter helpless. The son, too, being very young could do nothing for a livelihood. However, they managed somehow to eke out an existence. As soon as the son was old enough, he started to try his luck in some other country. But his mother and sister did not know where he had gone. After a time they got anxious about him, and thought they would go in search of him. They travelled to the same country as he had reached, and where he had been so prospered and behaved himself so wisely, that he had been appointed king. However, they did not know of this. By a striking coincidence they all met, and fell in love with one another; and the king married them both. In course of time the elder of the two bore a son, when it became known that she was the king's own mother and the other woman his sister. Then it was that the other wife took the child up in her arms and spoke to it the above mentioned words.

Ho tah ho, a lullaby.

75, *Muatabar májih chham gásuv zúj.*

My venerable mother has a grass zúj.

Ans. *Pahar*, a cottage with thatch roof.

Zúj is a long piece of cloth worn only by *panḍitánís*, extending from the crown of the head down to the small of the back.

This would seem to go against my note to No. 4, were it not for the qualifying adjective "venerable."

76, *Uláh karit chilas t̲s̲áv,*
Muk̲h̲tah mandilah gaṅḍit dráv,
Yáni buzuk, "Áv, áv,"
Tán k̲h̲alkan zúáh t̲s̲áv.
Taking God's name it entered upon forty days,
And then came out adorned with a turban of pearls.
When the people heard that it had come,
They got fresh life.

Ans. *Dáni*, rice (in the husks).

Rice is the staple grain of Kashmír. The inhabitants live chiefly upon it. Rice land is regarded as the most valuable of all land. Rice is sown in April and reaped in September. The grain forms and begins to ripen within forty days of sowing.

Uláh (for *Alláh*), the Supreme Being.
Chilas (for *chihil*), forty.
Mandilah, a *pashmína* turban.

77, *Lará lazam táh bah táh,*
Andar bíṭhis gandar káv,
Tim tih bíṭhis táh bah táh.
I built a house layer upon layer.
Inside it sat young crows,
They also sat one upon another.

Ans. *Ḍúngah*, a covert boat for passengers.

The fore-part is left for the passengers. The boat-people live in the after-part, which is separated and covered with matting. Often three generations together thus pass their lives.

Táh bah táh = Pers. *Tah ba taḥ*.

78, *Lam tal tham sath.*

Seven pillars under a heap.

Ans. *Honih hanzah babah sath*, the seven nipples of a bitch. Cf. No. 42.

79, *Másúvis chhánis gásuv raz.*

Your uncle (hanging by) a grass rope.

Ans. *Tolah wor*, the rope and earthenware vessel at the end of the *tol*. *Vide ante*, No. 4.

Mású, mother's sister's husband.

80, *Tatih loi kán, khut ásmán,*
Yĕtih loi kán, wot Hindústán.
Thence I shot an arrow, (and) it ascended to the sky.
Hence I shot an arrow, (and) it reached Hindústán.

Ans. *Ḍákuk k͟hat*, a postal letter.

The Kashmírí pandits say

Al Kashmír,
Janat nazír.

They believe it to have been the first paradise in the *mahá-yug*. The Musalmáns, also, regard it as a very holy country.

81, *Nah zah phuṭe* (or *phate*), *nah zah pháṭe, wasih sudras t͟shánṭe.*

It will never break, it will never burst, it will swim in the sea.

Ans. *Don*, the stick with which the butter is churned. *Vide ante* Nos. 10 *and* 31.

Sudr, contraction of *samundar*.

82, *Ḳuchhih haná ásam, tati ásam t͟surai k͟hár wátán.*

I had a little *kuṭ*, it held only four *k͟harwárs*.

Ans. *Ḍún*, a walnut.

The walnut flourishes in a remarkable manner in the valley. The fruit is cheap and good and largely eaten by the natives. *Ḍún* is the word for walnuts generally. There are four species, however, each of which is distinguished by a separate name. *Vide Kashmírí Proverbs and Sayings*, p. 229.

Kuṭ, vide ante No. 25.

K͟hár (or *k͟harwár*) a dry measure containing lbs 192. Its literal meaning is an ass-load (*k͟har*, an ass. Pers.) Cf. No. 33.

83, *Nílapal tsakajal; wustah kurih dakah dyut; wasit wut Khanabal.*

A great green stone,—the teacher's daughter pushed it, and it descended and arrived at Khanabal.

Ans. *Khyun*, eating.

The *great green stone* is the mouthful of food, perhaps cabbage—*the teacher's daughter* is the tongue, which gave the food a push, and it reached the stomach (*Khanabal*).

Khanabal is the name of a little village, where people disembark for Islámábád, Mártanḍ, etc.

84, *Wanakis dáras drih tah matsai,*
Amritah chhasan katsaiwán,
Wuchh tas zangan páyilah kåtsai,
Bezuwah chhasan natsaiwán.
The wood of the jungle has rings and bands,
I wet it with the water of life,
Look how many bangles she wears on her feet.
I make the dead to dance.

Ans. *Don*, the stick with which the butter is churned.

Vide ante Nos. 10, 31, 81. This stick has rings, etc., attached to the bottom end.

The "water of life" is the milk. Hindús of the country generally call it *amrita*.

85, *Lará lazam, lará lazam tsandanawe dárai;*
Sár Kashír pĕṭh lazmas, totih luts hárni.
I built a house, I built a house of sandal-wood;
And put all Kashmír on it, yet it was light as a shell.

Ans. *Khat*, a letter.

Kashmírí paper is supposed to resemble sandal-wood in colour; hence the comparison.

Kashmír is called *Kashír* by the Kashmírí.

86, *Herih wuth akhá,*
Buth karit trakhá.
A (man) descended from above,
Making his face (like) a *trak*.

Ans. *Al*, a pumpkin.

Pumpkins are trained to grow over skeleton houses. When they are ripe they fall.

Trak, a grain measure containing four and three quarter *sers* (full).

87, *Zah batah phali tah ak rasah dám.*
Two grains of rice and a drink of juice.

Ans. *Dachhĕh phul*, a grape.

There are several varieties of grape growing in Kashmír. The variety here referred to is called *Husainí dachh.*

Dám = Hindúst. *Ghuṇṭ.*

88, *Akhá bihit bád o hawáwas;*
Byákhá karán málas ráchh;
Trĕyim pherán t̲sor kunj álamas;
Timan tran chhuí kunuí náv.
The first sits in the wind;
The second takes care of the property;
The third goes round the four quarters of the world;
To these three there is only one name, (*i. e.*, the same name).

ANS. *Gánṭh,* an icicle, a string used as a strap, or a kite (the bird of prey).

89, *Watih pakán tah káv khanzán.*
Walking by the way and plucking a crow.

ANS. *Dachh khĕni,* eating grapes (on the road).

The vine may be seen in some parts of the valley hanging in beautiful festoons about the trees on the wayside in a wild state.

90, *Watih pakán tah t̲sángij t̲saṭán.*
Walking by the way and cutting the *t̲sángij.*

ANS. *T̲suṭ kheni,* eating bread (on the road).

This refers to the Hindústání *chapáti* (a flat cake).

T̲sángij, is a round piece of matting for sitting on.

91, *Kurih haná ásam, sui ásam pánas suĕt batah khĕwán.*
I had a litte girl, and she used to eat with me.

ANS. *Wáj,* a ring.

92, *"Abah gaṇ gaṇ, babah gaṇ gaṇ, kapar kichih kichih," son sikah bachah sairas dráv.*

(It cries) "*abah gaṇ gaṇ, babah gaṇ gaṇ, kapar kichih kichil*" (and) our Sikh boy goes out for a walk.

ANS. *Yindar,* a spinning-wheel.

The words in inverted commas are supposed to represent the sound the wheel makes when revolving. A Sikh boy is here mentioned because the top and bottom of the *yandartul,* (the little wheel of the spinning-wheel on which the thread being spun is wound) are fastened together with long hair; and a Sikh boy has long hair.

93, *Sah chhuh pakán rogih rogih. Shál chhis raṭit mag. Ak kánahwol, zah kánahwáli gásah tuliav pak.*

A tiger goes by the road side. The jackals lay hold of its mane. One boatman, two boatmen pull it along with blades of grass.

ANS. *Bahat̲s̲*, the largest boat with a mat or straw covering used for the carriage of goods.

Kánahwol, lit. the man who holds the *kán*, the *hamatul*, or long pole with which the boat is propelled.

The *blades of grass* refer to the ropes made of plaited twigs and straw.

94, *Kalah t̲s̲uṭui, kalah t̲s̲uṭui; kalas t̲s̲hanimas tabar.*
Nílah Nágah tresh cheyan, Warah-mulih búzus k̲h̲abar.

His head is cut off, his head is cut off; I struck at his head with an axe. He drank the water at Níla Nág, and the people heard of it at Báramúlá.

ANS. *Kalam* (*qalam*) a reed or pen, (used in writing a letter at Níla Nág (or Wernág); which letter was sent to Báramúlá.)

Reference is made here to the cutting of a reed with a knife to turn it into a pen.

Nílah Nág, or the fountain of blue water, is a celebrated fountain at a little distance from Shahbád in the southern end of the valley. It is generally called Wernág (or Bernág) after the ancient name of the *parganá* in which it is located.

Warah-mul is the correct name for the town commonly called Báramúlá, a town at the north-west end of the valley, where visitors change horses and coolies for the boats on their way into Kashmír. V, W, and B, are used indiscriminately by the uneducated, as among the Gascons, Spaniards and negroes.

95, *Shan rĕtan duh dahá tah shan rĕtan nah kinh.*

For six months smoke and for six months nothing.

ANS. *Hammám*, a hot bath.

Kashmíris only use the *hammám* for six months during the cold weather.

96. *Manz maidán harámgashtá,*
Wuḍih dit nárah tashtá.
An adulteress in an open field,
With a basin of fire on her head.

ANS. *Jajír*, a smoking pipe.

The *jajír* is compared to an adulteress because it is bandied about from one man to another. Everybody can take a whiff from it.

Wuḍ, the crown of the head; hence *wuḍih dyun*, to put on the crown of the head.

Tasht or *tast*, a shallow basin of brass, etc.

97, *Aurah wuth paṇḍit·treh ḍintáni ganḍit.*

A panḍit descended thence with three girdles round him.

ANS. *Zin bor,* a bundle of wood.

In Kashmír the term *panḍit* does not necessarily mean a learned bráhman. All Kashmírí Hindús, on the assumption that they all belong to the bráhman caste, are called panḍits.

Mention is here made of a panḍit, because in former years when this riddle was invented, panḍits only among the male inhabitants of the valley wore girdles like the Tibetans and Dárds of the present day. They gave up the custom about five years ago.

98, *Nílah palah talah gunasá dráye,*
Lach lokah márit bĕyih túri tsáye.
A snake came out from under a green stone,
And (after) killing thousands of people went back again.

ANS. *Shamsher,* a sword.

Gunas or *af'í* (ὄφις), is said to be very poisonous. It is a round-headed, short, thick snake, and is black on the back, and yellowish on the belly. Various accounts are given of its length. Elmslie says, "a foot and a half," Vigne says, "about a yard long." The *gunas* is said to be numerous in the Lár *pargáná.*

99, *Guḍah zái buh tah máj, adah záv bab,*
Doh pañshĕh dab gav záv buḍi bab.
First I and my mother were born, and then father.
(After that) for five days nothing happened, (when) grandfather was born.

ANS. *Kapasi kul,* the cotton plant.

Gossipeum, herbaceum, the common Indian cotton plant rises in Kashmír to nearly a foot and a half in height during the first year of growth. It is a pretty little plant. Its flowers are a bright yellow; each petal being marked with a purple spot near the base. The flower is succeeded by a fruit, which gradually becomes dry and then bursts into three or four valves, when the cotton-wool is seen issuing from it in all directions. The cotton is generally white.

100, *Dúr darakhtan sangarmálan,*
Kus hĕkih lálan mul karit?
Trees upon the range of hills in the distance.
Who can say (lit. make) the price of rubies?

ANS. *Kong,* saffron which is grown in large quantities on the big, flat plateau in the neighbourhood of Pámpúr, about eight miles from

Srínagar. It is very expensive—about a rupee is given for a rupee's weight. The flowers of the *Crocus sativus* are of a red colour, like rubies.

101, *Aubasih wolum baubasih raṭit; ditum barit.*
Mĕh dup, "Phuṭum." Torah khutum, Sháh Totah zan.

I pulled it down from above with a rope: I dashed it (into the water). I said (to myself) "It is drowned." (But) it rose thence like a king parrot (meaning nicely).

Ans. *Tolah wor.* The earthenware vessel at the end of the *tol*, *vide* description, *ante* No. 4.

Aubasih, above, and *baubasih*, a rope are old Kâshmírí. *Hĕrih pĕṭh* and *raz* are now always used.

102, *Yáni záv táni khut káni pĕṭh.*

When born it immediately climbed to the upper storey.

Ans. *Duh*, smoke.

The general plan of a Kashmírí house is:—First a ground floor, in which are two chambers with the small hall of the house. Then the second floor with three rooms. And over that the floor under the roof, generally consisting of one long chamber, where people usually sit during the summer, but which is used as a loft, for the storing of grain, wood, etc. during the winter. The latter is the *káni* (or *kanĕni*).

103, *Tal talí taláv khanán,*
Pádsháh garas lúṭ karán.
(Apparently) digging a very deep well,
(But really) robbing the king's house.

Ans. *Gagur*, a rat.

This is also a Kashmírí proverb and quoted concerning a traitor. Cf. *Kashmírí Proverbs and Sayings*, p. 209.

104, *Mumut zindas thaph karit.*

A dead man leading the living.

Ans. *Gudámih ganḍit push*, a beast held by a tether.

105, *Khyun, chun, tah trukun;*
Gov kyut khurák, tah wárih kyut wawun.
(Something) to eat, to drink, and to gnaw;
Food for the cow, and something to sow in the garden.

Ans. *Hĕndawĕnd*, a water-melon.

There is an amusing Kashmírí story, too long to repeat here, in which a foolish son is ordered by his father to go and get five things, something to eat, to drink, to gnaw, to feed the cow with, and to sow in the garden; and the boy advised by a clever girl brings back a water-melon. Cf. *Madanakámarájankadai (The Dravidian Nights)*, p. 63. for a similar incident.

Wár a garden—generally used for vegetable gardens.

106, *Ati chhúí tah raṭun.*

It is in your hand,—catch it.

ANS. *T̲s̲hái*, a shadow.

107, Four men went out in a boat and gave two *sers* of rice to the boatwoman to cook for them. The boatwoman began to cook the rice.

One of the party said:—*Káko, hár má ablahan tai karih, i. e.*, O father, take care that the starling does not get the better of the fools—meaning, See that the woman does not eat any of the rice.

Whereupon another of the party said:—*Brak tont karimas tah kor kun pai karih? i. e.*, I have broken its bill. What can she do now?—meaning, I have got my eye on her, etc.

Then another said:—*Sháh wot ḍali manzi. Hánz hĕt hai karih, i. e.*, The king has reached the middle of the lake, and will run about with the boatmen—meaning, The rice is ready for straining. Now the woman will let fall some of it.

On which the last of the party said:—*Pĕtas k̲h̲umáras, "mĕh wai." T̲s̲ĕh kyah karih.* I will pretend that I have got a drunken headache (and ask her to give) it to me. What can she do to you?

Kák is a term implying intense respect for the person thus addressed, and is common both to the Musalmáns and Hindús. A son will thus address his father; the younger members of a family will thus address their eldest brother; and any very respected person outside the family may thus sometimes be addressed. But the father only is called simply *kák.* I find *kákká* is the Muhammadan Singhalese word for "elder brother," and *cáccá* for "father's younger brother." The latter word is also in use in Southern India. *Kákká* is also used by the Malays of Ceylon for "elder brother." I cannot trace the origin of the words. In Telugu *kákká* means "father's brother," cf. also Ceylon A. S. *Journal* 1867—1870, p. 11.

K̲h̲umár, sickness, headache &c., the effects of drink. Rice-water is often given to alleviate sickness arising from intoxication.

108, *Lĕjan wuhan ṭhán wuh.*

Twenty lids to twenty pots.

ANS. *Wuh nam*, the twenty nails on a man's hands and feet.

109, *Chhatis baṭhis krahuni káv*
Timai karán ṭáv ṭáv.
Black crows on a white bank,
They are saying, "caw, caw."
Ans. *Kágazas pĕṭh lĕkhun,* writing on paper.

The paper is white, the words written thereon are black. The rustling of the paper, as you take it up to read it, is supposed to be the sounds of the words (written on it) speaking to you.

110, *Athav nah tai; khorav nah tai;*
Zorav suĕtin pakán chhuh.
Neither with hands, nor with feet,
(But) by its power it goes on.
Ans. *Saruph,* a snake.

111, *Sundarí phujkai wuganĕn bálan,*
Wah wah mushkár tráwán chhĕk,
Zah thah khĕwán, ak thah tráwán,
T̲s̲urim thah shama zálán chhĕk.
O Sundarí, you flowered on a high hill;
Well! Well! you are leaving scent behind you;
Two portions you eat, and one portion you throw away
(And) the fourth portion you burn in your lamp.
Ans. *T̲s̲er,* an apricot.

The oil expressed from apricots is called *khálí tíl.* Not much of it is used in the valley. Oil is also expressed from mustard, almonds, walnuts, and linseed.

Sundarí, a proper name (from the Sanskrit).

112, *T̲s̲huṭis wanas guṭil t̲s̲áv,*
T̲s̲aṭit kurnas kráv.
A sawyer went into a copse (and) cut and gathered some wood,
Ans. *Mas kúsun,* to cut the hair. *Vide* Nos. 70 and 129.

113, *Herih wut̲s̲ haṭ,*
Pharhang raṭ.
A bit of wood descended from above,
In a strong grasp of the hand.
Ans. *Kangani dini,* combing the hair.

Pharangí is a corruption of the Persian *farangí.* It here means the hand. Anything strong and capable is sometimes called *pharangí* in Kashmír.

Kashmírí combs are generally made of wood.

114, *Apárih taram khaṇkáh buḍá sahanih dit̲s̲anam t̲s̲hálah,*
Wuthit tah raṭanas nálah.

From that side an old woman, speaking through her nose, ran at me like a tigress, and jumped on me and held me to her breast.

ANS. *Nindar*, sleep.

115, *Pak pat̲s̲is, daph* (or *dap*) *shurĕn, boz pánas, wuchh mĕh kun,*

Go to the guest, speak to the children, listen to yourself, and look at me.

ANS. A man had cooked a sheep's head and legs for himself, wife, and children, and had just served them up, when a stranger came in. The wife looked at her husband to know whether she was to offer their guest any of the savoury food. The husband replied in the above words, which mean—Give the legs to the guest, the tongue to the children, keep the ears yourself, and give me the eyes.

116, *T̲s̲aṭit rang kat ?*
Raṭit mul kat ?
What has colour on being cut ?
What has value on being laid hold of ?

ANS. *Hĕndawĕnd tah mukhtah*, a water-melon and a pearl.

117, *Gáṭuj kurih han poṭ wĕtsahnán.*
The little girl is teasing out the silk.

ANS. *Kangani*, a woman's comb.

118, *Babo pyos, Májai pyos,*
Pyos nah pyos wutsh hai khyos.
O Father, I fell down, O Mother, I fell down,
And I had hardly fallen down, when a calf ate me.

ANS. *Peomut panah-barg*, (Skr. *parṇa-varga*), a fallen leaf.

119, *Mut t̲s̲ul put dárih,*
Kulai hĕt aṭahbárih.
The mad fellow escaped by the back window,
Taking his wife on his back.

ANS. *Duh*, smoke.

120, *Langi guri lat tráv,*
Mukhtah gav chhángare.

A one-legged (lit. a lame) horse kicked,
And pearls were scattered.

ANS. *Muhilih suĕti munun,* to pound with a pestle.

Chhángare is very old Kashmírí. Now-a-days the words *chhĕkaranah yun, pareshán gatshun* and *chhakunah yun,* are used.

121, *Wanas lĕvih kus?*
Who will wash the jungle?

ANS. *Rúd yá shín,* rain or snow.

122, *Wanas ḍuvih kus?*
Who will sweep the jungle?

ANS. *Wáv,* the wind.

123, *Pĕwán chhuh moḥá zan;*
Samán chhuh kohá zan;
Tsalán chhuh tsúrá zan;
It falls like a musquito;
Collects together like a great hill;
(And) runs away like a thief.

ANS. *Shín,* snow.

124, *Navih lĕjih gadi sat.*
A new pot with seven holes in it.

ANS. *Buth yá kalah,* the face (which is likened to a new pot, because it is clean).

125, *Guris pĕṭh hust.*
An elephant on a horse.

ANS. *Khrávih pĕṭh mahnyuv,* a man walking in pattons.

I have heard something like this in Persian:—
Chíst án chíst dar jahán bisyár,
Fíl rá dídam o bar asp sawár.

126, *Huti yut.*
(Going) hither and thither.

ANS. *Yĕni yeruni,* sorting the warp.

127, *Hul ganḍit batich natsán.*
Tightening her girdle the duck dances

ANS. *Pruts,* a little apparatus forming part of the spinning-wheel and intended to receive the thread.

This is also a saying, cited against a woman, who wishing to quarrel, goes and unites in a "row" close by. Kashmírí women have terrible tongues and most shrill voices. At the time of quarrelling they screech, shout, and dance till they are too hoarse and too tired to go on.

128, *Záme, zuse, punde, ase ;*
Nĕt sanán karih tirthan,
Waríh waryas nunuí áse ;
Nishih chhuí tah parzantan ;
He will yawn, cough, sneeze, and laugh ;
He always bathes at the sacred places ;
Year in and year out he will remain naked ;
He is near to you, recognise him.
ANS. *Buth*, the face.

129, *Ávah maháráj sávah jangas tulunávanas gaṭakár.*
The *maháráj* came and entered into the fight and destroyed (them).
ANS. *Mas kásun*, to shave the head.
Gaṭakár tulunáwun, lit. to cause darkness to arise.
Vide Nos. 70 and 112.

130, *Gugusi gugusi gugáliye gajih tih gugus kaḍ,*
Bah (or *buh*) *nai kaḍai rindáliye atih chhuh bihit ṭhag.*
Be careful, O woman, mind and take it out of the oven.
I will not take it out, O woman, (because) a robber is sitting there.

ANS. *Zanánah jorá ásah, yimav tsuchih ásah karit, gajih manz thavimatsah. Tamih waktah wot timan nish ak beyánah. Akih zanánih dup bĕyis kun titai páṭh, yuth nah zih puts bozih, zih tsuchih kaḍ gajih manzah. Tami dyutus jawáb, zih buh kaḍah nah, tikkázih yih mahnyuv chhuh atiti.*

There were two women who had made some bread and put it in the oven. At that time a stranger came to them. One woman said to the other in such a way that their guest might not understand, "Take the bread out of the oven." The (other) woman replied, "I will not take it out, because there is a man there."

Gugusi, gugusi, gugáliye, rindáliye, are words merely made up for the occasion in order to deceive the stranger.

I protested against including the above in this little collection; but everybody, that I asked, declared it was a riddle, so I have put it in.

131, *Áyeyas tah gayeyas ;*
Kukú lanjih becheyas ;
Mudur ásas tah kut gayas ?

I came and I went;
I sat on many branches;
I was sweet—and where did I go?

Ans. *Nindar*, sleep.

Kukú is old Kashmírí. *Wáryah*, *sĕṭhah*, are now used.

132, *Anzinih hande nágarádo, anzinih kuḍanai pawo;*
Chháni guruk nah, králi thuruk nah; pánai byuṭuk suwo.

O spring of the goose, the goose made its way to you;
No carpenter cut it, no potter formed it; but you of yourself became hardened (lit. sat hard).

Ans. *Tulah-katur*, ice on surface of water.

133, *Hápat kándur; breṭh panḍit; talim poni hyur khasán; breri bráhman; gagar suts; káshuri párimi; shál gáḍah-hánz; thapal sarráf.*

Bears (are) bakers; stupid people (are) panḍits; the lower waters flow up; cats (are) bráhmans; rats (are) tailors; Kashmírís (are) Panjábís; jackals (are) fishermen; usurpers (are) bankers.

Ans. *Purshiyár*, the name of a *gháṭ* in Srínagar city just below the second bridge.

A man was going to a village, when he was met by another man, who asked him where he was going and whence he had come. He replied as above that he had come from the place where bears were bakers, etc., etc.

134, *Khatis andar máz kúchih haná.*

A little piece of flesh in the cupboard.

Ans. *Zyav tah ás*, the tongue in the mouth.

Khat is a small cupboard let into the wall, wherein Kashmírís generally store rice, milk, etc., to preserve them from rats and cats.

135, *Bálas pĕṭh kálah saruph, laṭ tah kár milawit,*
Aurah áyas Zuhrah Khotan laṭ nínas gilawit.

A black snake on a hill with its tail and neck together, (lit. making its tail and neck to meet).
Zuhrah Khotan came over and wrenched off its tail.

Ans. *Kuluph*, a padlock.

136, *T̲s̲or chhis rabis manḍán; t̲s̲or chhis khandam ṭúri; zah chhis charágánah; zah chhis tír-andázah; ak chhus morchhalah karán.*

She treads the mud with four; four are dishes of sweets; two are lamps; two are archers; and one fans her.

Ans. *Gáv*, a cow's feet, teats, eyes, horns, and tail.

137, *Apárih bál ḍoṭ pĕwán;*
Yapárih bál shín pĕwán.
On that side of the hill hailstones are falling;
On this side of the hill snow is falling.
Ans. *Káḍi yindar*, a cotton-carder.

138, *Yak mashíde do darwázah;*
Áo miyán tráo poṭásah.
One mosque (with) two doors;
Come, sir, and bang on it.
Ans. *Khani kaḍuni*, to blow one's nose, (native fashion).
Vide Nos. 43 and 63.

139, *Soyih tal poyih lĕj.*
A potfull of rice under a nettle.
Ans. *Kukarih hanz púti khej*, a hen with her brood.

140, *Sundará ḍiṭham-dud kamání;*
Nah marih shistarah nah marih nárí.
I saw a beautful woman—an arch of smoke;
She will not die by iron, she will not die by fire.
Ans. *Duh*, smoke.

Notes on a Donative Inscription of Vidyádhara Bhan̲ja, belonging to C. T. Metcalfe, Esq., *Commissioner of the Orissa Division. (With a Plate.)*

—*By* Rájendralála Mitra, LL. D., C. I. E.

The muniment is inscribed on three plates of copper, each measuring 6 × 3½ inches, the thickness being about one-tenth of an inch. The plates are held together by a stout copper ring surmounted by a cast copper seal bearing in relief the name of the donor and an effigy of a lion *couchant guardant*. The plates are of cast metal, roughly hammered, and having all round a slightly raised edge. This edging is designed to prevent injury to the record by friction. The record is engraved on the second face of the first plate, and on both faces of the other two plates, each side comprising 7 to 8 lines of matter. On the first side of the first plate there are indications of letters traced with a steel-pointed style and afterwards smudged. Such tracings are also noticeable on the other plates, and they suggest to me the idea of the plates being palimpsests. At first I was disposed to think that the tracings were the first outlines made for the guidance of the engraver; but I find this idea is not tenable, inasmuch as the tracings appear sometimes below and sometimes above the regular lines of the engraving, and not engraved over, as they should have been, had they been the first outlines. The finished record is deeply engraved, and, except in a few places, the letters are in a fair state of preservation.

The letters of the record are of the Kuṭila type merging into the modern Devanágarí form. The vowel *i* retains the old three-dotted form; the *e* is indicated at times by a slight curve at the hind part of the top line, and at other times by a curved line behind, as is usual now in Bengali writings. The letters *l* and *ṇ* are alike in shape, being differentiated only by the omission of the top line, as was the case in the Bengali of the last three centuries. The *j* is also of the form of that letter in Bengali. But the *t*, *d* and *bh* are of pure Kuṭila type.

The language is pure Sanskrit, though, as is usual in records of this description, it is disfigured here and there by errors of spelling; slips of grammar are also not wanting. I have pointed out the more prominent of these errors in parentheses. On the whole the record does not in this respect differ from its congeners found in other parts of India. In the neglect of punctuation the record beats the attorneys of England.

The most remarkable feature of the record is, however, the absence from it of the prosy details which characterize ancient Indian grants, as also the title-deeds got up by English conveyancers. We altogether miss the "to have and to hold and to possess" so familiar to us in modern English deeds of sale or gift. In mediæval Sanskrit deeds, the field produce, the forest produce, the produce of water, with all that is under the ground or above it, are carefully noted, also exemptions from Government demands; but nothing is said of them here; even the important item of the boundary of the land given is not mentioned.

The subject of the gift was a village named Tuṇḍuráva, in the district of Vimalabhanja, but I have failed to trace it in our maps. Judging from the word *Bhanja*, which occurs both in the name of the district and also as a surname of the donor's family, I am disposed to think that we must look for the *locale* somewhere in the present tributary state of Mayúrabhanja, in the north-west of Orissa. But the evidence is too slender to be of much value in this respect, particularly when it is borne in mind that the word Bhanja was borne as a surname not only by the Rájás of Mayúrabhanja, but also by a family of Rájás in Gumsur, as also by the Rájás of Keunjhar. The last, however, were scions of the Mayúrabhanja dynasty, whose initial date was not older than two hundred years ago, and therefore could not have had any part in making the grant. The village or town, in which the Rájá was present when he made the gift, bore the name of Valjalvaká, and this too is not traceable. Bábú Dharitrináth Deva, a relative of the Bhanja Rájá of Mayúrabhanja, informs me that he knows of no place of that name, and that Vimalabhanja was never a second name of Mayúrabhanja. I have not yet succeeded in getting any information in regard to this place from Gumsur.

The donee was one Bhaṭṭa Dárukhaṇḍí of the Data sept *(Pravar.ı)* of the Upamanya gotra. He belonged to the Bahvṛicha S'ákhá of the Ṛig Veda. His father's name was S'úrideva, who was the son of one Gaurichandra.

The donor describes himself as a Mahárájá, but the names of his father and grandfather occur without any regal prefix. The great-grandfather, however, is described as a Rájá, and we may safely presume that the epithet is expected to be assumed in the two intermediate cases. The names stand thus :

Rájá Vraṇabhanja Deva.
Divabhanja Deva.
Sílíbhanja Deva.
Mahárájá Vidyádharabhanja Deva.

The last claims to have been a devout worshipper of Mahádeva *(paramamáheśvara)*, and this declaration is emphasized by the two introductory stanzas which praise the attributes of that dread divinity. Of his race the only information vouchsafed is that he was an "ornament of the Bhanjana race" *(Bhanjana-kula-tilaka)*. It is obvious from this that the words *Bhanja* and *Bhanjana* are synonymous and exchangeable, but it helps to take us no further. We possess no account whatever of these *Bhanjanas.* Bábú Dharitrináth Deva has not heard of the name of Vidyádhara in the Bhanja genealogy, and knows nothing of him. He has not yet been able to obtain for me a copy of the family tree of his relative, and in matters of this kind memory is not at all reliable. Few persons in ordinary life can correctly recite the names of ten of his ancestors, and few would attempt to do so. In the absence of positive information I am disposed to think that I have in the record before me the names of four members who are now quite forgotten in the annals of the Mayúrabhanja dynasty. I am disposed to think, too, that there exists no complete record of the family from the date of its origin. Only a few of the Tributary Mahal chiefs can appeal to any record of an older date than two hundred years, though several of them have unquestionably exercised their chiefships from generation to generation for a much longer period.

The record has no date. This is an unusual peculiarity, the rule being otherwise, though the era used has often caused, in the absence of precise indications, considerable trouble to antiquarians. It would seem that the practice of issuing copper patents was recent in the country where Vidyádhara issued his grant; at any rate his court paṇḍits must have been very ill-informed about the fundamental requirements of title-deeds, not to adopt the niceties of conveyancing terminology. I have stated above that the letters are of the Kuṭila type merging into the modern Devanágarí, and this fact would suggest the idea of their being between four and five hundred years old, and the deed to belong to the fourteenth or the earlier years of the fifteenth century of the Christian era. In the present state of my information, I regret, I cannot speak with greater precision.

The concluding part of the deed gives the names of the attesting witnesses. The first name is that of the minister, Bhaṭṭa Stambha Deva, who put his 'mark' on the deed for its ratification. The Sanskrit word used to indicate this is *lánchhita*, which means 'marked,' but I suppose it is intended to imply the impressing of the deed with the great seal of the State. The epithets applied to his name are not very clear. The first word is the most doubtful; it reads very like *S'rishṭhi* which probably stands for *S'reshṭhi*, a 'banker.' This man came from the *Kalinga* country, was a worshipper of S'iva, whence *Mahádevya*, and endowed with great energy, *tejahika.* The last word is of doubtful import. The second witness is named Kauśika. He caused the grant to be 'entered' *(praveśita)* in the *Bábbá.* Kauśika has no epithet of any kind attached to his name. He was obviously an officer of an inferior grade, and he has not even the courtesy S'rí assigned to him. The word *bábbá* is not Sanskrit. I take it to be the sanskritized counterpart of the Arabic *Báb*, which in the plural form of *Abwáb* or cess became current from the date of the first settlement of the Muhammadans in this country. One meaning of the word is a book, chapter, or section, and I imagine it stands here for a registry book or that chapter of it in which a record was kept of rent-free grants. I draw this inference entirely on the strength of the word *praveśita* 'entered.' The composition of the deed is attributed to S'rí Khamba, the minister of war and peace. The engraver was one Kshasálí Kumárachandra. In this I take Kumárachandra to be the personal name and Kshasálí the name of his caste.

Translation.

May that which can destroy the life of the wielder of the flowery arrow (Cupid); to whose mass of light the weak crescent is an object of overthrow; which is the refulgent lamp for the illumination of the regions of the threefold world; which is fair as gold of the purest touch*—may the eyebrowless eye† of Hara be victorious!

May the waves of the heavenly river of Sambhu, which play like the hoods of the great serpent, which glisten bright as the light of the rising moon, which dance like the crests of the spurs of the snowy mountain, which rise like hands at the commencement of a dance, which are radiant, and destroy sin—may they protect you!

Prosperity. The auspicious dweller of the victorious Valjalvaká, the home of fortunate victory * * * the ardent worshipper of Maheśvara, the devoted to the feet of his father and mother, the ornament of the Bhanjana race, Mahárájá S'rí Vidyádharabhanja Deva, the great-grandson of S'rí Vraṇabhanja Deva of manifest merit * * * and totally devoid of the sins of the Kali age, the grandson of S'ri Divabhanja Deva, the son of S'rí S'ilíbhanja Deva, according to the desert of each, welcomes, respects, acquaints and orders the people, inhabitants, subordinate chiefs, receivers of income, village officers and others of the prosperous district of Vamalabhanja. Everywhere there is happiness. It has been our fortune, for the promotion of virtue for our parents and ourselves, to present in due form with the usual pouring of water the village of Tuṇḍuráva as it is bounded now in that district, to Bhaṭṭa Dárukhaṇḍí, of the Upamanya gotra, Data Pravara, the grandson of Gaurichandra, son of S'úri Deva, and a member of the Bahvṛicha S'rotriya branch, out of respect for his merits, for the period of the duration of the sun and the moon. It should be the duty, for the sake of the greatness of the merit of charity and our request, for future kings to protect this grant. Thus has it been enjoined by the ordinances of religion. Earth has often been given away by Sagara and other kings, and the merit thereof has belonged to him to whom the earth belonged for the time being. Whoever resumes earth, whether it be his own gift or that of another, is, along with his ancestors, born as a worm and rots in ordure. Let there be no doubt, O kings, about the merit from the fact of its being another's gift. The merit of protecting others' gifts is infinitely greater than that arising from one's own gift. Knowing this and knowing that the duration of man's life and fortune are as unsteady as water on a lotus leaf, no man should destroy the good actions of others. Marked (sealed) by the Minister Bhaṭṭa Stambha Deva, who is a banker (by caste) of Kalinga, a worshipper of Mahádeva, and highly energetic; entered in the Bábbá (register) by Kauśika; written by S'rí Khamba, the minister of war and peace; and engraved by Kshasálí Kumárachandra.

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* The epithet *kanaka-nikasha* is in frequent use in Sanskrit poetry, but the explanation of it is of doubtful propriety. They say it means the mark left on the touchstone by gold; but surely that mark is nothing very bright. I take it to mean pure gold which has stood the test of the touchstone.

† The word is *vibhrunetra*, an eye without an eyebrow. The object of using the epithet is to indicate the third or crescent eye of S'iva over which there is no eyebrow. The fact of the word for eye being put in the singular number confirms this interpretation. Had the word been *babhru* the translation would have been 'tawny,' but that would not have been sufficiently distinctive, as in art all the three eyes of S'iva are painted of a tawny colour.

Transcript (see Plate IX).

(First plate.)

१। × जयतु कुसुमवाणप्राणविक्षोभदक्ष(क्षं) स्वकि-
२। रणपरिवेषोर्ज्जित्या(त्वा)जीर्णेन्दुलेखं त्रिभुवनभवना-
३। न्तर्द्योतभास्वत्प्रदीपं कनककनी(नि)कषगौरं विभ्रनेत्रं
४। हरस्य(॥) घोषाहेर(रि)व ये फणाः प्रविलसन्त्युद्गा-
५। सुरेन्द्रत्विषः प्र(प्रा)लेयाचलशृङ्गकोटय इव(वो)त्त-
६। ङ्गन्ति यत्प्र(येप्रो)न्नता(।) नृत्ता(त्या)टोपविघट्टिता इव भुजा रा-
७। जन्ति ये शाभवा(शाम्भवा)स्ते सर्व्वाघविघातिनः सुरस-
८। रित्तोयोर्म्मयः पान्तु वः(॥) स्वस्तिविजय वञ्जल्वका-

(Obverse of second plate.)

१। द(व)स्ति श्रि (श्री) विजयनिलयः प्रकटगुणगणाढ्य-
२। स्तसमस्तरी (रि) पुवर्गजि × × कलशनामा रा-
३। जा नी (नि) र्द्धूतकलिकलुषकल्मषश्रीरणभञ्ज(1)देव-
४। स्य प्रपौत्र(त्रः) श्रीदिवभञ्जदेवस्य नप्ता श्रीशि-
५। लाभञ्जदेवस्य सुतः परममाहेश्वरो माता(तृ)पि-
६। तृपादानुध्याता भञ्जनलकुलतिलको महारा-
७। जश्रीविद्याध(र)भञ्जदेवस्य(वः) कुशली(॥) वमलभञ्ज(2)—

(Reverse of second plate.)

१। विषये यथानिवासिसामन्तभोगिभोग्यादिवि-

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1. The word *bhanja* has been everywhere written with the cerebral ṇ thus भण्ज.

2. The letters are doubtful in this name.

२। षयजनपदं यथार्हं मांनयति पूजयति बो-
३। धयत्यादिशति चान्यत् सर्व्वतः शिवमस्माकम-
४। दृष्टे तद्विषयसम्बन्धतुग्डुरावग्रामचतु(तुः)सीमा-
५। पर्य्यन्तः ग्रामेाय(यं) ॥ मातापित्रोरात्मनश्च पुण्या-
६। भिवृद्धये श्र (श्चा)चन्द्रार्कसमं कालं यावत् सली (लि) लधा-
७। रापुरःसरेण विधिना गुणानुराग(गा)त् क(1) × × × × ×
८। उपमन्यगोत्राय दत(2)प्रवराय वह्वृचश्रोत्रिया-

(Obverse of third plate.)

१। य गौरिचन्द्रः नम्ना (गौरिचन्द्रनाम्ने) सूरिदेवस्य सुत(तः) भाट्टदास-
२। खण्डी ॥ नाम्ने प्रतिपादितोस्माभिस्तदेषा दानध-
३। र्म्मंगौरवादस्माकमनुरोधाय भविष्यद्राजकैः
४। प्रतिपालनीयेत्युक्तञ्च धर्म्मशास्त्रे बहुभिर्व-
५। सुधा दता(त्ता) राजभिः सगरादिभिर्यस्य यस्य यदा
६। भूमिस्तस्य तस्य तदा फलं(॥) स्वदत्तां परदत्तां वा
७। येा हरेत वसुन्धरां(।) स विष्ठाया(यां) कृमी (मिः) भुत्वा पि-

(Reverse of third plate.)

१। तृभिः सह पच्यते(॥) मा भूदफलशङ्का वः परदत्ते-
२। ति पार्थिवाः स्वदानात् फलमा(न)न्त्यं परदता(दत्ता)नुपाल-
३। ने(॥) इति कमलदलाम्बुबिन्दुलोलां श्रियमनुचि-
४। न्त्य मनुष्यजीवितञ्च सकलमी (मि) दमुदाहृतञ्च बुद्धा
५। न हि पुरुषैः परकीर्त्तयेा विलेा(प्याः ॥)काञ्छितं श्रेष्ठिकलि-
६। ङ्ग महादेव्यतेजहिकेन श्रीभट्टस्तम्भदेवमन्त्री (न्त्रि) णा वा-
७। त्वाप्रवेशित(तं) कौशिकेन लिखितं सान्धिविग्टहि (विग्रहि) श्रि (श्रो) खम्बे-
८। न उत्कि (की) र्णं च । हसालीकुमारचन्द्रेन (णा) × × ।

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1. Five letters are unintelligible.
2. I know of no Data Pravara. The second letter (त) is doubtful.

Notes on the ancient mounds in the Quetta District.—*By* MAJOR J. F. GARWOOD, R. E.

(With a Plate.)

Now that portions of Baluchistán and Southern Afghánistán are rapidly becoming settled countries under British rule, doubtless men of science will begin to devote some attention to the mounds which are spread abroad throughout the district. Up till recently, what with the country being unsettled and constant changes of officers taking place, the little information that is forthcoming regarding these mounds is hard to be got at. It is for the most part a personal record, and the persons are constantly shifting on the scene.

I had occasion recently in my official capacity as an officer of the Military Works Department to make some considerable excavations in the Miri or citadel of Quetta, and finding the results from an archæological point of view interesting, I have endeavoured to find out what has been done before by others in investigating mounds in the district, and purpose to put this now before your readers together with my own experience at Quetta. It will I hope be of advantage when the researches are taken up by experts, if some little information as to what has been noticed by those first on the spot is readily obtainable.

These mounds are very numerous throughout the district, some being of very large size. They vary from small hillocks up to large masses of earth, like the Quetta Miri, the base of which is an oval 600 feet long by 400 feet wide, and which rises 80 feet above the plain. These mounds may be, and very probably are, of different origins, and a few of the small ones may be even natural; but the true mound of which I write is manifestly artificial, and for the most part there is no sign of excavation in the neighbourhood. Accepting the conclusion that the mound is artificial, I argue that when no trace of excavation appears, we may be sure that the mound is of great antiquity for the dust storms of the country to have filled up the hollows from which the earth for the mound was taken.

Some officers quartered at Thal Chotiali a few years since took considerable interest in investigating the mounds there. Col. Sturt, Bo. S. C., found in a hole in a mound between Dubber Khot and Thal two or three gold and a number of silver coins which were sent down to the Royal Asiatic Society at Bombay and the inscriptions deciphered by Mr. Rehatsek. The coins were from Baghdad and about six or seven centuries old. Brigadier Adam, Q. M. G. of the Bombay Army, Col. Sturt's successor, informs me that he searched the mound afterwards and found nothing of interest, nothing except broken pottery which he believed to be modern.

There is a very large mound near Kila Abdullah in the Peshin plain at the foot of the Khoja Amran mountains. In 1881 Capt. (now Major) Lock, Political Agent, Peshin, dug into this mound under the orders of Col. Sir Oliver St. John, K. C. S. I., R. E. Major Lock is on furlough, but Sir O. St. John has kindly supplied me with his recollections, which I will give as nearly as possible in his own words.

"Underneath layers of mud, charcoal, or rather charred wood, and bones were a number of small rooms built of very large baked bricks, as far as I can recollect about 18 inches by 10 inches by 6 inches. These bricks had no markings or inscriptions of any sort."

"In the rubbish were found fragments of pottery, *bits of glass*, copper, brass and iron. Two at least of the fragments of pottery had been bottoms of basins or round dishes and were glazed yellow, with indented and separately coloured figures on them, in both cases, of men leading goats. The best of the two I gave to the British Museum in 1881. What became of the rest of the things I do not know. The excavations were incomplete when I left."

The Quetta Miri is a mass of indurated clay. On the top were a few old houses, probably occupied formerly by the maliks of the village or small township of Shálkot, the houses of which were grouped together under the shadow of the Miri. In 1883, before I came to the district, the base of the mound was cut into for a magazine, and previously to that some tunnels had been run well into the mound. Nothing of particular interest seems to have been found, or my predecessors would have left some record of it. Some bones I hear were come across, including some human bones, the only ones found at any time recently in the mound.

About a year ago I commenced clearing the top of the Miri for some buildings. This necessitated cutting the top 15 feet off the mound, besides excavating in places to an extra depth of about 5 feet or 20 feet in all. During these excavations one could not fail to be struck with the peculiar constitution of the material of which the mound is composed. In every direction the soil is permeated by bones, broken pottery, ashes in layers, and charred wood or charcoal. The bones are said to be the bones of domestic animals, but of what animals I do not know at present, but have sent samples to Calcutta for identification by competent anatomists. The remains got comparatively few as the depth increased, but were always present in considerable numbers. Near the top very large *jallás* or *ghaṛás* frequently occurred; no such articles of pottery are I believe now made in the district. The general impression, left on the minds of those of us who were constantly present during the earth clearance, was not that the remains were necessarily of any very high antiquity, as that the mound must have been occupied by constant successions of people for an indefinite period. I am still quite puzzled to account for the presence of so many lumps of charred wood at considerable depths, most of them quite fresh and shewing the grain of the wood. From Sir Oliver St. John's account the same peculiarity was noticed in the mound at Kila Abdullah. The charcoal of course might be of any age, being comparatively indestructible, but its existence in such large quantities in the aggregate is very puzzling. The buildings, I do not think, are likely to have been periodically destroyed by fire, as in some of the old Greek towns, and the presence of the lumps of charred wood is more probably due to some use the mound was formerly put to; but this of course is mere personal conjecture.

The articles of interest, few in number, which we found in the Quetta Miri, have been sent to the Indian Museum at Calcutta. There are some fragments of pottery of an archaic type, which were found in the lower strata of the excavations, and also a ringstone and jasper corn-crusher, which the Museum authorities think are probably prehistoric. They were found on a low level, but higher than the Greek statue afterwards unearthed. There was also found a small bronze vessel which may be Greek; and at the lowest depth attained to, and near the centre of the mound in plan, a bronze or copper statue of Heracles, 2¼ feet high, holding in his left hand the skin of the Nemean lion (see Plate X). The statue, which was much corroded but otherwise nearly perfect, was found standing nearly erect, bedded in hard clay. The ground below and around was carefully excavated to a distance of several feet, but nothing further was found except a few animals bones.

At a medium level was discovered a small vase of common pottery, with angular markings in paint round the swell of the vase below the neck. I am anxious to find out the probable date of this vase, as Major Shepherd, R. E., found a lot of pottery with similar markings on it near Bellali (ten miles north of Quetta) in 1885. There is a large *miri* near Bellali, but in Major Shepherd's absence in England I have not been able to ascertain whether it was in the *miri* or elsewhere that he found it. Nothing more of interest is likely to be discovered just now in the Quetta Miri, but in considering the comparative poverty of our findings in such a promising site, it must be borne in mind that the excavations only went down to a depth of 20 feet out of the total height of 80 feet of the mound, and anything of extreme antiquity would probably be found lower down.

Our excavations having connected this district with the Greek period, at least ought to encourage others more competent to carry the investigations of these mounds further, and Capt. Lock's discoveries at Kila Abdullah in 1881 seem to have been even more interesting.

The Mother of Jahángír.—*By* H. Beveridge, C. S.

It is curious that there should be any uncertainty about the name and family of Jahángír's mother. He was born in August 1569 at Fatḥpur Sikrí in the house of Salím Chishtí, and it was to be expected that the historians who have so carefully chronicled the circumstances of his birth, would tell us who his mother was. But apparently none of them mentions her name; or, at least, none of them does so in his narrative of the birth. Jahángír is equally reticent in his autobiography, and so English writers have fallen back on tradition and conjecture. This much seems considered certain; the lady was a Hindú, and it has been suggested that this is the reason why she has not been named by the Muhammadan historians. I should think, however, that if Hinduism has had anything to do with the omission, it is more because it made it difficult for the historians to know the name, than because of bigoted feelings, or an unwillingness to hint that Jahángír was not a pure Mogul. Jahángír has no scruple about mentioning his Hindú wives and their progeny, and though he speaks with horror of Muhammadan women marrying Hindús, he has very little blame for the converse practice. Barring a few bigots like Badáoní, it may be questioned if the Muhammadan subjects of Akbar and Jahángír had any serious objections to the marriages with the Rájpút princesses. Indeed Sir William Sleeman tells us that he has heard many Muhammadans attribute the decline of their empire to the discontinuance of the practice. Muhammadans might object to the ladies being allowed to remain Hindús, and no doubt Akbar caused scandal by allowing his wives to sacrifice to fire in his palace, but the fact that the wife was a Hindú by origin would be no objection. Rather it would be considered meritorious to convert a Hindú to the true faith and then marry her.

Now if the lady who was Jahángír's mother was a Hindú by origin, she can hardly have remained one, or she would not have been placed in the cell of a Muhammadan priest at the time of her confinement. Nor would she have been *buried* after death and a Muhammadan tomb erected over her. Still less could she continue a Hindú, if, as Mr. Blochmann thinks, she received the title of Maryamu-z-Zamání, "the Virgin Mary of the age." That it was ignorance rather than prejudice, which prevented historians from giving the names of their emperor's Hindú wives, may be perhaps inferred from the fact that we find two ladies described by the name of Jodh Báí. Now Jodh Báí is not the special name of any woman, but simply means that she belonged to the family of the Rájás of Jodhpur.

At p. 309 of his edition of the Áín Mr. Blochmann tells us that

Jahángír's mother was Jodh Bái, but at p. 619 he corrects himself and says that Jodh Bái was the wife of Jahángír, and that there is little doubt that the daughter of Bihárí Mall and sister of Bhag'wán Dás was the mother of Jahángír.

It is with great hesitation that I venture to differ from Mr. Blochmann, but here the hesitation is diminished by the fact that we have Mr. Blochmann differing from himself. He originally held that Jodh Bái was the mother of Jahángír, and it seems to me that he was wrong to abandon this view in favour of Bihárí Mall's daughter. What I think he overlooked was that there were two Jodh Báís, *i. e.*, two ladies of the harem of Jodhpur. One of them was the sister of Udai Singh, *i. e.*, the Moṭá or fat Rájá, and married Akbar, and the other was Udai's daughter and married Jahángír.

The general native belief seems to be that a Jodh Bái was the mother of Jahángír, and I think that weight should be given to this. Sir William Sleeman in his Rambles, vol. II, p. 65, speaks of his seeing the tomb of Jodh Bái, the mother of Jahángír, near Agra. Further on, pp. 68 and 71, he speaks of seeing the little room at Fatḥpur Sikrí where she give birth to Jahángír. Similarly Tod describes Jodh Bái as the mother of Jahángír.

On the other hand the daughter of Bihárí Mall is mentioned by Jahángír in his Memoirs in a way which seems to me quite inconsistent with the idea that she was his mother. Speaking of Paháṛ K͟hán who was Rájá Mán Singh's uncle and consequently a brother of Bhag'wán Dás, he says "One of his sisters was in my father's harem, but no favourite with destiny, although possessed of uncommon beauty. The proverb says 'if there be any special destiny, it is for the ill-favoured,' for from all I can observe in this workshop of creation, scarcely anything appears in its proper place. The poor in spirit are absorbed in the rigour of abstinence, while those who love the world find their fortune ever in advance." (Price's translation, p. 34.)

This passage seems to me to disprove the view that Bihárí Mall's daughter was Jahángír's mother. No man would be likely to speak in this way of his own mother, and Jahángír would not have regarded a woman as no favourite with destiny who had the honour of giving birth to himself.*

There is another passage in his Memoirs which sets the matter at rest, if the translation is correct. That is (Price, p. 19) where he tells us that he himself married Bihárí Mall's daughter, but I suspect that it is granddaughter in the original.

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* I cannot find any passage corresponding to this in the Tuzuk. I have not seen the Persian original of Major Price's translation.

It will be observed that Mr. Blochmann is not positive about Bihárí Mall's daughter being Jahángír's mother. He only says that there is little doubt of it. I think that the passage from Jahángír's Memoirs, and the tradition about Jodh Bái show that Bihárí Mall's daughter was not Jahángír's mother, and if the latter was a Hindú, I think that we have no choice but to accept the tradition that a lady of the house of Jodhpur was the mother. Perhaps, however, it has been too readily assumed that she was a Hindú. I have already observed that it is very unlikely that a Hindú lady would be taken for her confinement to the house of a Muhammadan priest, and I now proceed to offer reasons for holding that Jahángír's mother was a Muhammadan, and no other than Salímah Sulṭán Begam, the widow of Bairám K̲h̲án.

There is a passage in Elliot's History of India, Vol. VI, p. 404 which, if it can be fully relied upon, settles the question of who was Jahángír's mother. We are there told that Núr Jahán was brought to court after the death of her husband Sher Afgan, and entrusted by Jahángír to "the keeping of his own royal mother." Now we know that Núr Jahán, when brought from Burdwan to Agra by Jahángír's orders, was placed in the keeping either of Salímah Sulṭán Begam, or of Sulṭán Raqiyah Begam. The Iqbálnáma of Muḥammad K̲h̲án, and K̲h̲áfí K̲h̲án say Salímah Sulṭán, and Mr. Blochmann and Muḥammad Hádí (Elliot, VI, p. 398) say Raqiyah. But the latter borrows his account from Muḥammad K̲h̲án, and if the Bibliotheca Indica edition is to be trusted, Muḥammad Hádí or Elliot has mistaken the word *raqabah* "a slave" for Raqiyah.

The original in the Iqbálnáma, p. 56, is as follows—

انحضرت بنابر غباري كه از كشت قطب الدين خان برحواشي خاطر اشرف
نشستة بود برقبة ساطان بيگم والده سببي خويش بخشيدند .

I do not feel sure of the meaning of the words *wálidah sababi k̲h̲esh* which Elliot seems to have rendered "his own royal mother," but surely they mean something more than that she was his father's wife. Raqiyah was alive and probably others of Akbar's wives. Why then should an expression be applied to Salímah which was not at all distinctive of her?

The expression is repeated with a variation by K̲h̲áfí K̲h̲án, I, p. 267, who calls Salímah the *mádar nisbat-i-k̲h̲ud* of Jahángír.

Elphinstone also, 4th ed., p. 484, tells us that Jahángír placed Núr Jahán "among the attendants of his mother." His account is evidently taken from K̲h̲áfí K̲h̲án, and represents the view taken by the translator whom he studied.

That Salímah was closely connected with Jahángír and deeply interested in him is apparent from the fact that she went to him, when he had fallen out with his father and brought him to Court, and that she tended his son Prince Khusrau from his infancy. Elphinstone accounts for Salímah's mediation by saying that she had adopted Jahángír after his own mother's death, p. 460. But I do not know what authority there is for this statement.

If the words *wálidah sababi khesh* really mean "own mother," there can be no doubt that Salímah was Jahángír's mother, for Muḥammad Khán was in a position to know the facts.

Jahángír speaks of Salímah's having a daughter and calls the latter his sister, but as I have not the original to refer to, I cannot say if this means full sister.

On the other hand, if this daughter was Sháhzáda Khánam, and if she was born three months after Jahángír (Blochmann, p. 308), Salímah cannot have been the mother of the latter.

If Salímah was Jahángír's mother, he ought to have been a better man than he was, for she was the most distinguished of Akbar's wives. She was the niece of Humáyún, being the daughter of his sister Gulburg Begam (Akbarnáma, II, p. 65) and of Mírzá Núru-d-dín Muḥammad. Akbar gave her in marriage to Bairám Khán in accordance with Humáyún's intention, and when Bairám was assassinated, Akbar married her himself. She died in 1021 A. H. (1611). Kháfí Khán calls her Khadije-uz-Zamání, the Khadija of the age and after reciting her virtues and accomplishments winds up with quoting two lines of her poetry, which however do not seen remarkable (Kháfí Khán, I, pp. 253 and 276).

Notes on the Coins mentioned by Major Raverty in his Notes to his Translation of the Ṭabaqát-i-Náṣirí.—*By* CHAS. J. RODGERS, M. R. A. S., Assoc. M. A. S. B.

There can be no doubt whatever about the amount of learned research displayed by Major Raverty in his translation of the Ṭabaqát-i-Náṣirí, published by the Asiatic Society of Bengal. It is a book of 1296 pages exclusive of memoir and additional notes and appendix. The actual translation in only a small part of the whole work. My attention has of late been drawn to his numismatic notes.

Mr. Edward Thomas, as is well known, wrote a paper on the coins of the kings of Ghazní, and to this he added a supplement. He also wrote "The Chronicles of the Paṭhán kings of Dehlí," to which I have added four supplements, in the pages of this Journal. It may be remembered that my first small attempt was a paper on the coins of Khusrau Sháh and Khusrau Malik, the two first resident Muhammadan kings of Lahore. At the time I wrote this paper I was not aware that Mr. Thomas had written his paper on the kings of Ghazní. This did not so much matter, as my paper was written thirty-two years after that one by Mr. Thomas, and dealt with other coins. Mr. Thomas gives in his paper two silver coins of Khusrau Sháh and five coins of Khusrau Malik. Major Raverty thus notices Mr. Thomas's paper (see note, p. 114). "In Mr. Thomas's paper on the Ghazní coins, there is unfortumately no notice of the last two monarchs of the house of Sabuk-Tigín, and there are no coins of theirs, or the dates I have referred to might have been tested; but a work I have by me supplies some information on the subject, and confirms the statements of Faṣiḥ-í, and the older writers. A coin of Khusrau Sháh's, therein noticed, contains the following inscription, which I translate literally :—

Obverse :—Stamped coin in the universe, with magnificence and grandeur, the great Bádsháh Khusrau Sháh.

Reverse :—Struck in the city of Lohor, A. H. 552, the first of his reign.

Another coin of his son Khusrau Malik, also struck in the Panjáb, contains the following inscription :—

Obverse,—Ẓahír-ud-Daulah wa ud-Dín, Sulṭán Khusrau Malik.

Reverse :—Struck in the city of Lohor, A. H. 555, the first of the reign."

About this note I have a few remarks to make. But I would first notice that Khusrau Sháh is called in the text "*Sulṭán Mu'ayyan-ud-Daulah wa ud-Dín*" (p. 111). To this on the same page (footnote 8) is added "In a few copies he is styled '*Yamín-ud-Daulah*' only."

On all the coins of Khusrau Sháh's which I have seen he is called "*Mu'izzu-d-daulah* Khusrau Sháh" only. With respect to the inscription, given by Major Raverty as being on the coin of these kings, I would remark that in all the coins of these kings of Ghazní the name of the mint and the year of the Hejirah are *always on the margin* which encloses a second inscription. *In no case is the year of the reign given.* I have seen some thousands of Ghazní and Paṭhán coins of Dehlí, but as yet I have never seen the year of the reign given on one. The years of the reign began to be struck by Akbar in his 30th year which he called 30th Iláhí. (See my Rupees of the months of Akbar's Iláhí years, Journal A. S. B. Vol. LII, Pt. I 1883, pp. 97-105 with two plates.) Jahángír struck the year of his reign and the year of the Hejirah on his coins. After his 5th year *he* also called the year of his reign *Iláhí.*

Sháh Jahán also struck coins with *his* Iláhí year on them in the first years of his reign. He was afterwards content with just putting the year of his reign and the Hejirah year. Aurangzíb was the first to write on his coins *sanat-i-julús* so and so. This was on the reverse along with the mint. The year of the Hejirah was almost invariably on the obverse along with the emperor's name. This custom was afterwards followed by all the Sulṭáns of Dehlí down to Bahádur Sháh the mutineer.

It seems strange that I, who have been hunting in the Panjáb for coins for the last twenty years, should never have seen a coin like the one mentioned by Major Raverty. Mr. Thomas never saw one. The British Museum has not got one, neither has the Asiatic Society of Bengal. Out of the thousands of coins sent to me for reading and description not one has yet appeared bearing such inscriptions. Coins *of the type,* mentioned by Major Raverty, are *of the time of Aurangzíb, or later.*

Major Raverty's coin of K͟husrau Malik reads "Ẓahír-ud-Daulah wa ud-Dín." I have by me over 50 coins of this king. They all read either "*Táju-d-daulah*" only, or "*Suráju-d-daulah.*" Major Raverty in his text calls him "*Táj-ud-Daulah*" (p. 114).

While on this point it may be as well to notice that Major Raverty (p. 109) calls Bahrám Sháh of G͟hazní *Mu'izz-ud-Daulah,* following, strange to say, "*chiefly modern authors,*" although "Faṣiḥ-í" and "Guzídah" and ten silver coins in my cabinet unite in calling him "*Yamín-ud-Daulah.*" Four coins given by Mr. Thomas have the same. In note 1, page 488, Major Raverty says "I imagine it is this title of his (Mu'izzu-d-dín Sám's) coins (ناضر اميو المومنين) which Mr. Thomas reads as the name of the K͟halífah. Un-Náṣir-ud-Dín 'Ullah was certainly K͟halífah at this period."* Mr. Thomas does not mention "Náṣir-i-Amíru-l-Múminín" in connexion with the coins of Mu'izzu-d-dín Sám. Major Raverty has mis-read and misrepresented Mr. Thomas.

Again in note 3, p. 497, Major Raverty says "it is quite a mistake to suppose that I-yal-dúz [يلدز only is on the coins] ever styled himself Sulṭán-i-Mu'aẓẓam." His coins, however, have السلطان المعظم, the very words.

On pp. 524-5 we have "It is stated in another work, the K͟hulásat-ut-Tawáríkh that Kuṭb-ud-Dín ascended the throne, at Láhor, on the 11th of Rabí'-ul-Awwal, 603 H., and that he read the k͟huṭbah for himself, and coined money in *his own* name, and yet, although the coins of others are, comparatively, so plentiful, it is stated that not one bearing the name of Kuṭb-ud-Dín has ever been found. A work in my possession, which contains specimens of the different coins of the Sulṭáns of Hind, with the inscriptions they are said to have borne, gives the following as a specimen of Ḳuṭb-ud-Dín's coins" :—

سکۂ وارث ملک و نگین سلطان قطب الدین ایبک في سنه ۶۰۳
ضرب دارالخلافۂ دهلي جلوس ۱

About this inscription I wish to say: (1) the word *sikkah* in all Paṭhán coins, when used, comes after the word ẓarb, thus ضرب هذه السکه (see Thomas). (2) Again the year *on early coins* is never given in figures and never with the Sulṭán's name. (3) The word *julús* never occurs on a Paṭhán coin. (4) Dehlí is never called Dáru-l-khiláfat until the time of Quṭbu-d-Dín Mubárak Sháh (716-720 A. H.), the vilest of Sulṭáns, who called himself "*Khalífah Ullah*" and "*Khalífah i Rabbu-l-Álamín*" on his coins, and who changed the simple *Ḥaẓrat Dehlí* to *Ḥaẓrat Dáru-l-khiláfat.* After his time Dáru-l-khiláfat was not used as the title of Dehlí on coins, until the time of Sháh Jahán who calls it, "*Dáru-l-khiláfat Sháhjahánábád.*" It is sometimes called *Ḥaẓrat Dehlí* simply, or *Dáru-l-mulk, Dehlí,* or *Dáru-l-mulk Ḥaẓrat Dehlí.*

Hence it would seem that Major Raverty must have got hold of a book written by a native later than the time of Aurangzíb, who began the use of the word *julús,* who used the whole of the reverse of his coins for the mint name and year جلوس میمنت مانوس, and who occupied the obverse with his name and titles and the year of the Hejirah. It is altogether incredible that a series of coins of the first years of a series of kings should be found, (those kings the earliest Sulṭáns of Lahor and Dehlí), bearing inscriptions dissimilar to all known coins of the period, but agreeing with the coins of the time of Aurangzíb and his successors. At least, if a series of such coins be found by one man, it is probable that some other collectors may obtain an odd specimen of the series. Now, as yet, no one has ever found a coin of this kind, except the anonymous and unknown author of a book in Major Raverty's possession. It would be a real benefit to the numismatic world to publish the book, and put an end to the doubts which are entertained about it. Besides this, we want to see drawings of coins, such as the following (see note, p. 530) :

هذا الدرهم مسکوک باسم الملك ظل الله آرام شاه في سنة سبع و ستمایه
ضرب دار السلطنة بلدۂ لاهور

This coin makes no mention of the Khalífah, a fact always stated on the coins of the period: the year is on the same side as the king's name, contrary to the usage of the period; the word *maskúk* is used contrary to the custom of such coins; and the title *Ẕillu-l-láh* is used instead of *Sulṭán.*

Again Náṣiru-d-dín Qubáchá is called by Major Raverty *Ḳabá-jah* (p. 531). The word is on the coins قباجه. This may be read with "fat'ḥah" (*Ariana Antiqua*, p. 434, coin 33, Pl. XX., fig. 19.) Fortunately we have the same word in Hindí on other coins. Here the word is कुबाचा, which gives us plainly Kubáchá as the pronunciation of the time. Comment would be superfluous.

Of the coins of Shamsu-d-dín I-yal-titmish we have the following given as the inscription in the work possessed by Major Raverty (p. 624):—

ضرب هذا الدينار بحضرت دهلي سنه اثنا عشرو ستمايه
قمع اللكفر و الصلابه سلطان شمس الدين جلوس احد

That this work was written after the time of Sháh Jahán, we have here almost certain proof. Sháh Jahán's coins of his first year have سنه احد. Aurangzíb's coins begin the use of *julús aḥd.* Jahángír's have ا over the word *núr*, to indicate the first year of his reign. The word هذا is *always* written on the early coins هذه· The form هذا is modern.

If we wanted any other proof of the time when Major Raverty's book was written, we have it in the next coin given (p. 630):—

Obv. تخت را چون گذاشت شمس الدين پاي بروى فشرد ركن الدين
Rev. ضرب دهلي جلوس ميمنت مانوس احد مطابق ٦٣٣ هجري

Here we have ميمنت مانوس associated with جلوس. This formula was invented by Aurangzíb, (see 'Álamgír Náma, published by the Society, p. 367), as will be seen when the coins of the Moguls of India shall be published. Then, the word هجري is never used along with the year, except on some rare rupees of Sháh Jahán. Akbar and Jahángír had used the term Iláhí for their years. Sháhjahán returned to orthodoxy, and though he uses the words سنه احد, he adds the word هجري to the year ١٠٣٧. This is the only occasion on which I have seen the word used. I have never seen the word مطابق used on a coin as "*equivalent to,*" as it is used in the above inscription.

The inscription on the coin of Raẕiyyat (commonly written Rezia) is given as follows (p. 637):

Obv. عمدة النسوان ملكة زمان سلطان رضية بنت شمس الدين ايلتمش
Rev. ضرب بلدة دهلي سنه ٦٣٤ جلوس احد

Here ٦٣٤ is a misprint for ٦٤٣. Dehlí is never termed on any coin I have seen بلده. It is always *Ḥaẕrat,* or in one case *Takhtgáh.* The whole inscription is quite unlike anything *known* of the time of Rezia, or of her father, Shamsu-d-dín. The absence of the name of the Khalífah stamps the inscription as the work of a person unacquainted with the coinage of the period. ايلتمش is always written التمش on the coins of Shamsu-d-dín.

The next coin given is as follows (note 6, p. 649) :—

Obv. مخرالدرهم و الدينار باسم سلطان معزالدين بهرام شاه فی سنه سبع و ثلث و ستمايه
Reverse :— ضرب دارالخلافة دهلي جلوس ١

Here we have the usual absence of margin. All the long inscription is on the obverse. How could it be on the surface of a rupee? The reverse, as usual, is full of anachronisms.

The next coin given is of A'láu-d-dín Maṣaúd Sháh, (note 9, p. 660) :—

Obverse :— المفق بنظام الملک من عند الله سلطان علاءالدين مسعود شاه
Reverse :— ضرب بادة دهاي سنه اربعين وستماية جلوس احد

From this coin we note the absence of the full title given to all the early Paṭhán kings, so and so *ud-dunyá*. This always precedes the *ud-dín*. In all the coins given this part of the formula is absent, as is the introductory *as-Sulṭánu-l-'Aẓim*. It is more and more evident that the author of the book had seen few of the early rupees of Dehlí. The whole known series of coins follows a fixed formula.

Of Náṣiru-d-dín Maḥmúd Sháh "The following is given as the inscription on two of his first coins, a *dirham* and *dínár*, (note, p. 672) :—

Obv.—هذا الدرهم مسکرک باسم سلطان العادل الد باذل ناصرالدين محمود شاه
Rev. :— ضرب بلدة دهلي سنة ٦٤٤ جلوس احد

The other runs thus :—

Obverse :—الناصرلا حكام الشريعة بحق المبين سلطان ناصرالدين جلوس ١
Reverse :— ضرب هذا الدينار بحضرت دهلي سنة اربع و اربعين وستمايه

Thomas did not give a dínár of this king. The British Museum has not got one. I had one. The Hon. Mr. Gibbs edited a second. Both these had *the reverse* above given as the margin on both sides. Both had *us-sikkah* instead of *ud-dínár*. The reverse of the dínár is the nearest approach to an inscription of the period. But it is not of the reverse, but of the margin of the reverse in case of rupees, and of the margin of both sides in case of mohurs. (See my 4th Supplement to Thomas just published in the Journal of the Society.) It is evident the author of the book had not made himself acquainted with the inscriptions used by

Maḥmúd, inscriptions which vary only in one word (year of course excepted),—بن is used for ابن.

The Ṭabaqát was written in the reign of Náṣiru-d-dín Maḥmúd Sháh, and hence his coins are the last given from the book in the possession of Major Raverty. This book is of course responsible for the inscriptions. The Major says very judiciously about each coin that "it is said in the book in my possession to have the following inscriptions." Who the author may be, I cannot tell. I can only judge from what he puts before me. He says the coins are of a certain number of kings. The first suspicious thing about them is, that they are all of the first year. Now if the author obtained coins of the first year, he must have obtained coins of other years. After twenty years of diligent search I have obtained few rupees of the early Paṭháns of Dehlí and not one of the 1st year of any king. I never heard of any one having a first year of any of these kings, though some of my correspondents have rupees of these early Sulṭáns. They all follow one formula.

Obverse:—Name and title of Sulṭán.
Reverse:—Name of Khalífah.
Margin:—Mint and year.

In the case of gold mohurs the margins are on both sides in several instances.

In the series given by Major Raverty's author not one coin follows the formula. But as I have shown the author has followed the formula of the rupees of Aurangzíb and of those who succeeded him. Hence I am led to the conclusion that Major Raverty, ignoring the great labours of Mr. Thomas and desiring to give something new and striking to the world, has been taken in by a most impudent series of forgeries, the work of a man almost, if not altogether, unacquainted with the coins of the later Ghazní kings and of the early Paṭhán Sulṭáns of Dehlí. Mr. Thomas gives six plates and a number of detached wood cuts to illustrate his text. If Major Raverty will publish his author with illustrations, the two works can then be compared. It is unfair on the part of Major Raverty, not to give the name of his author and to pit him against Mr. Thomas. It is only fair perhaps for me to state in conclusion that I think Major Raverty has been duped. A careful study of the chronicles of the Paṭhán kings would have compelled Major Raverty to put the book in his possession into the fire. Nothing in it is of the slightest value.

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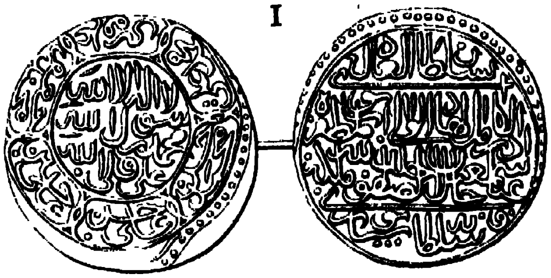

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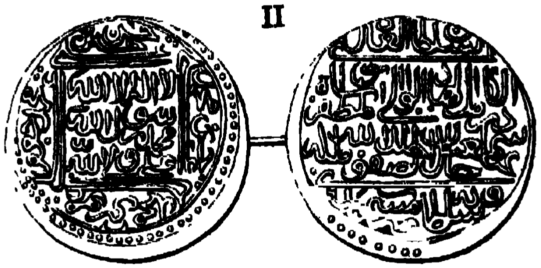

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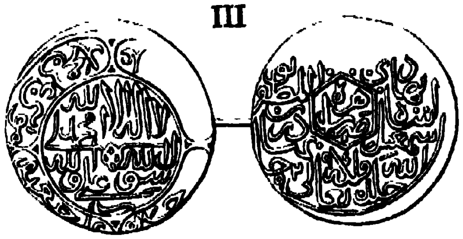

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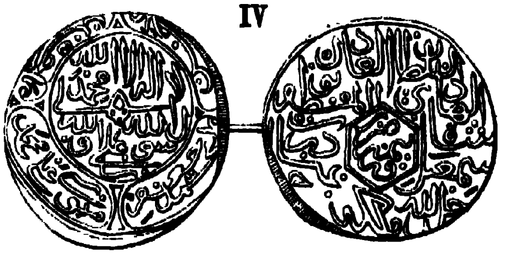

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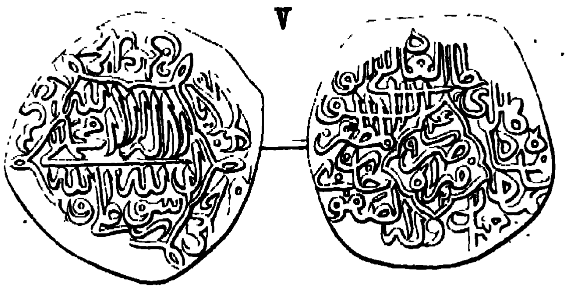

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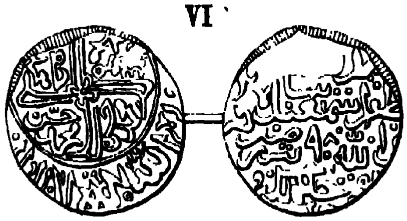

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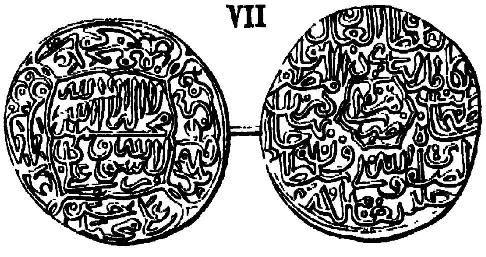

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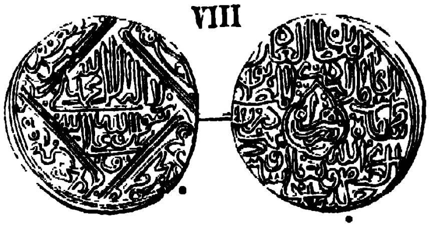

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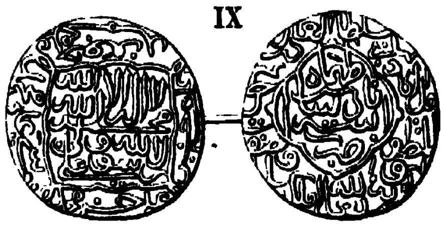

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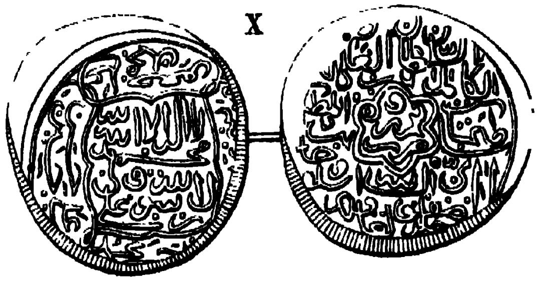

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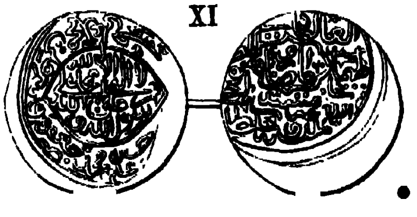

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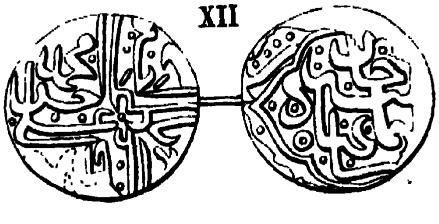

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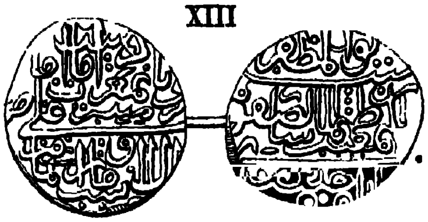

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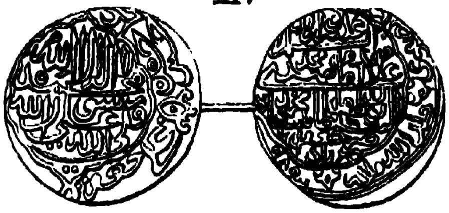

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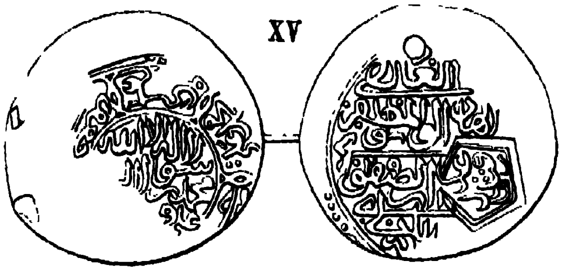

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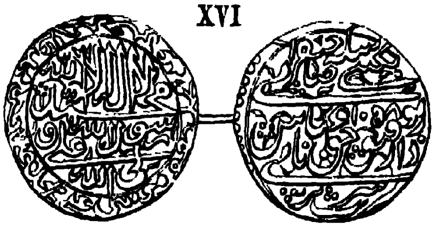

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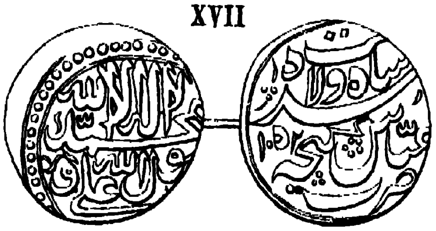

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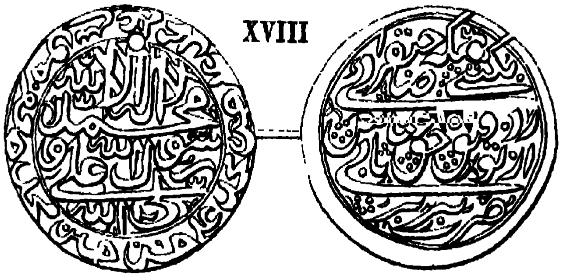

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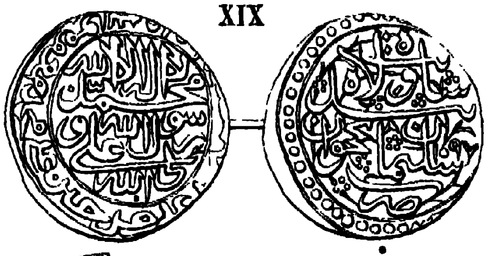

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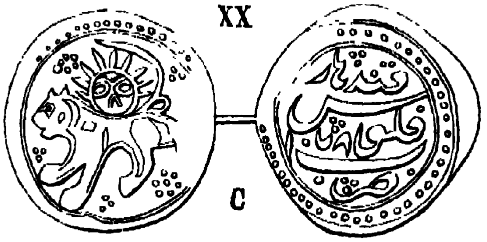

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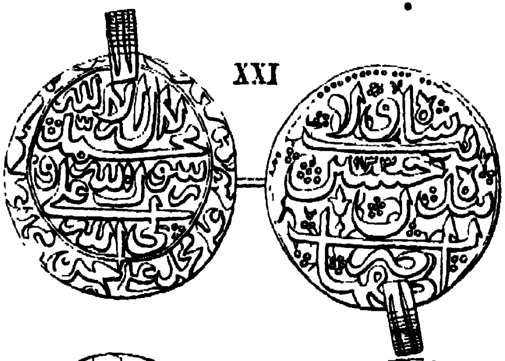

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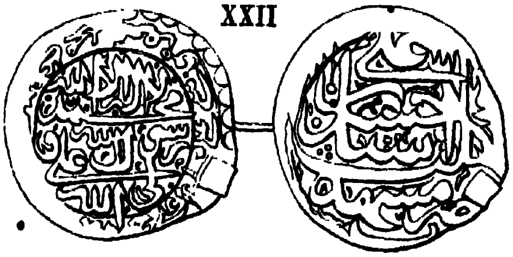

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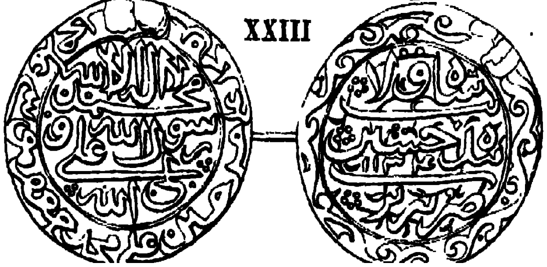

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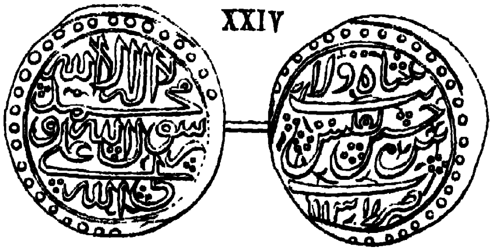

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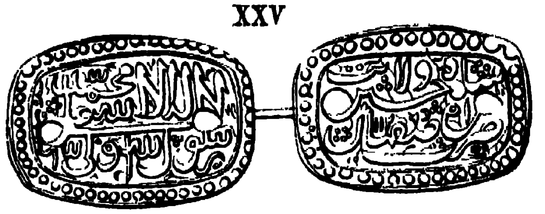

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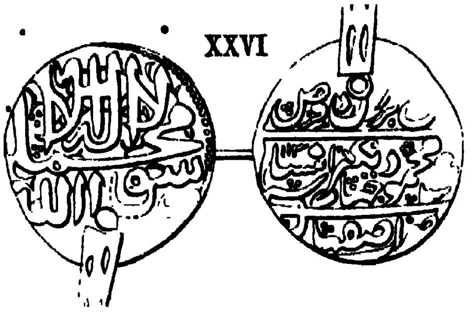

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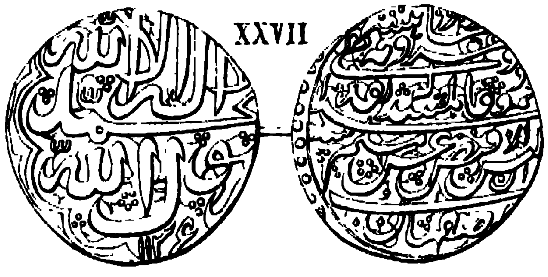

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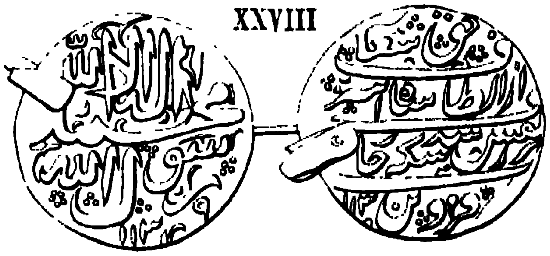

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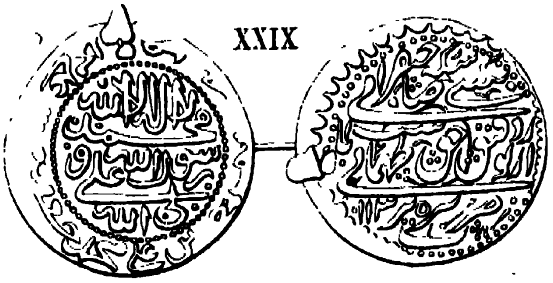

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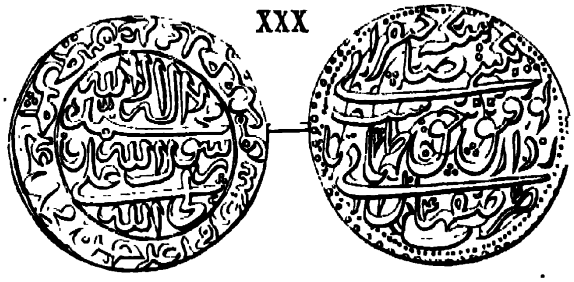

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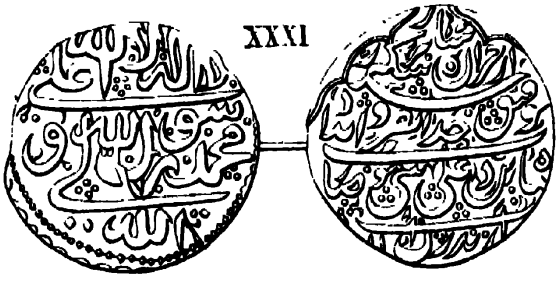

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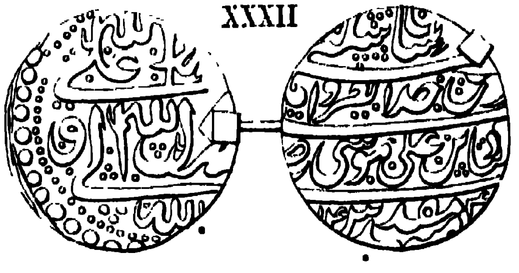

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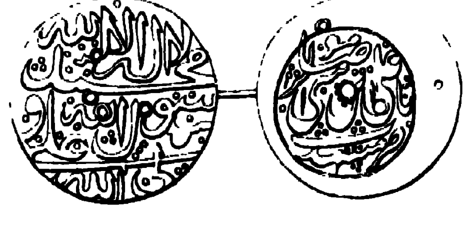

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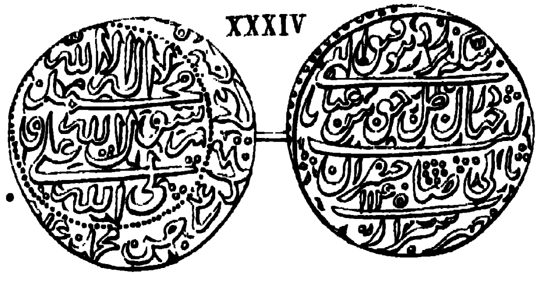

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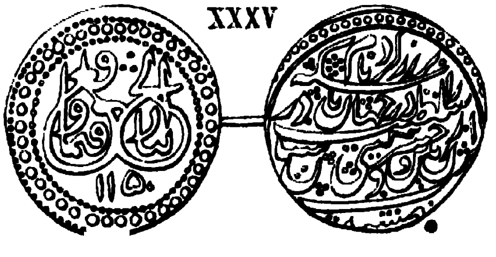
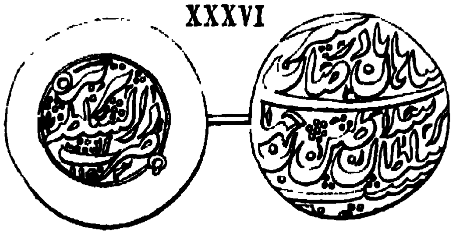


XXXVI



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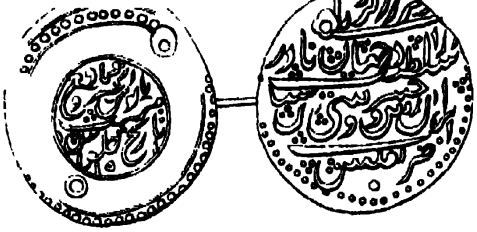

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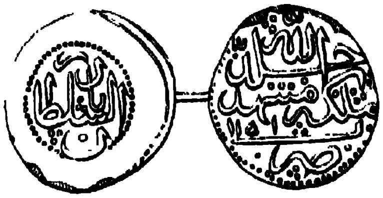
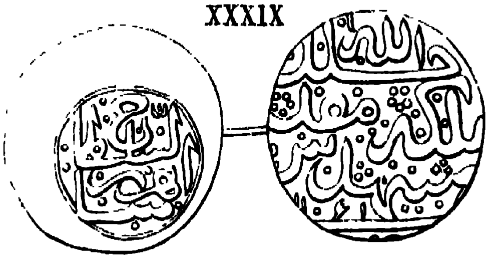


XXXIX



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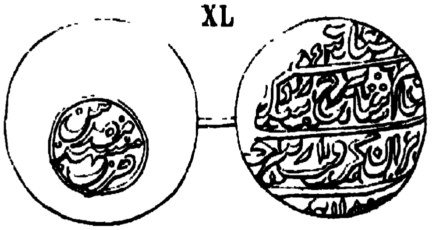

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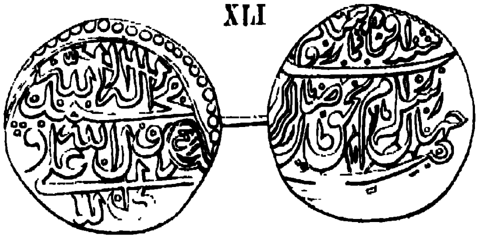

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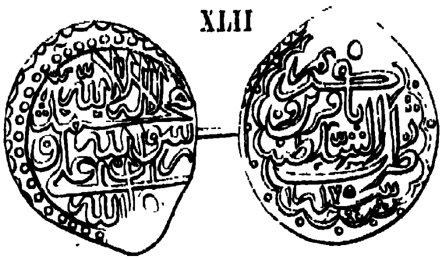

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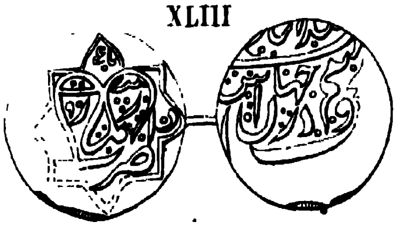
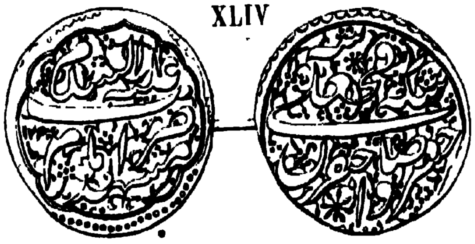
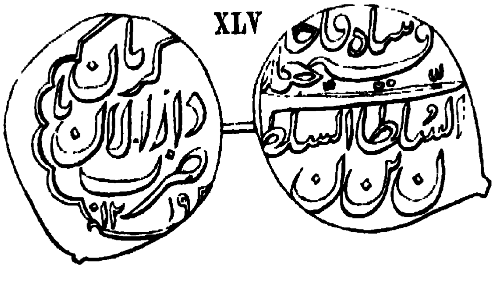


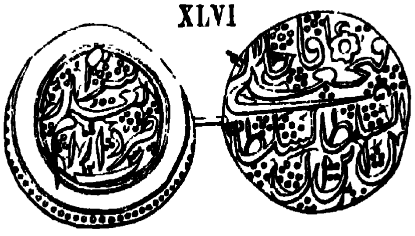
XLIV



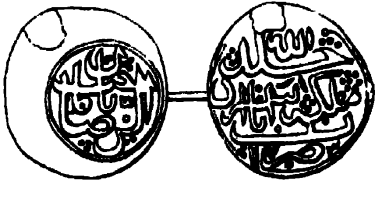
XLV



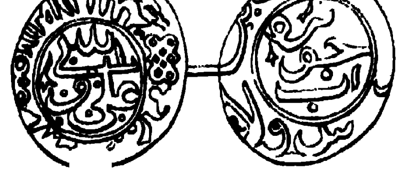
XLVI



XLVII



XLVIII



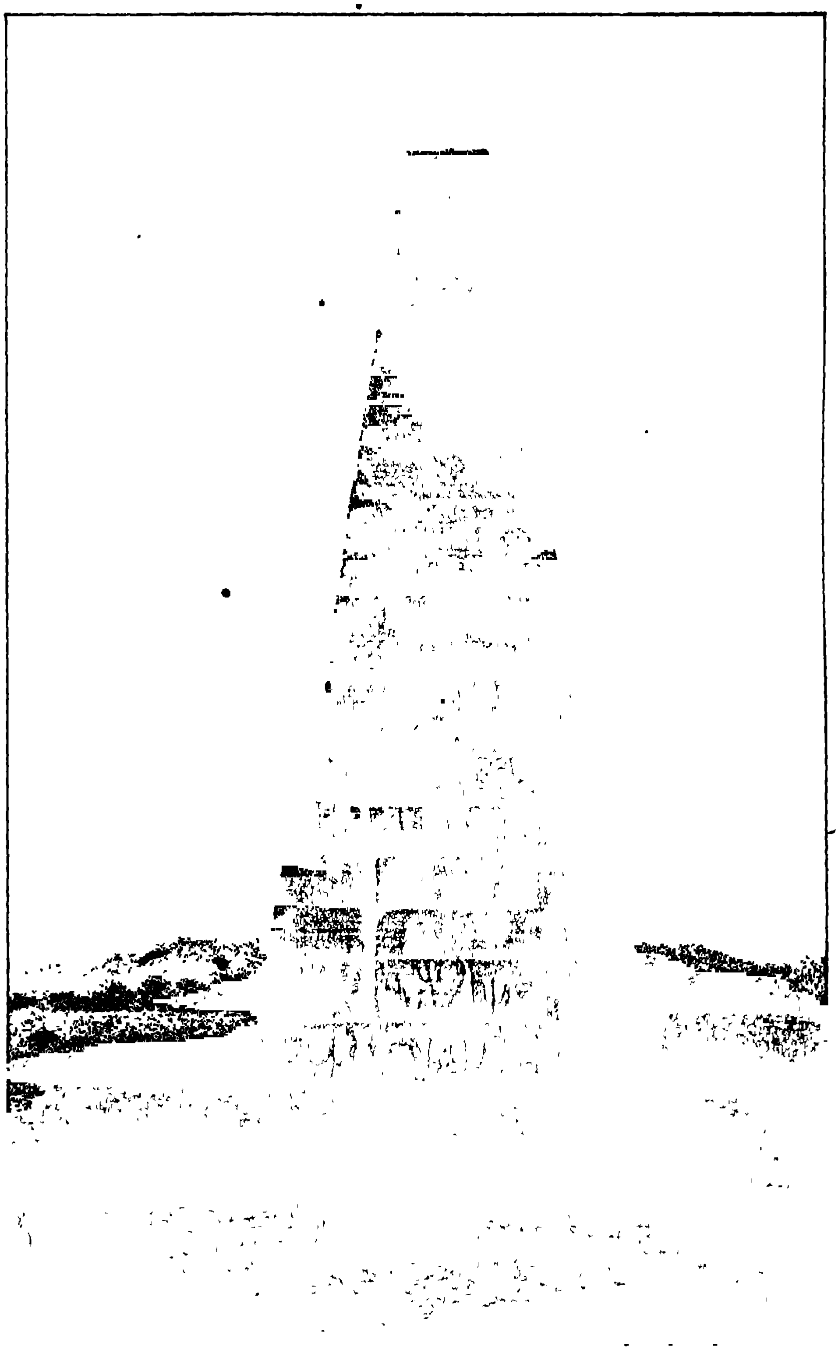


Photo by Sirdar Vishnu Singh Forest Ranger Meywar

THE 'UBH' DÍWAL OR AKBAR'S LAMP, NEAR NAGARÍ.

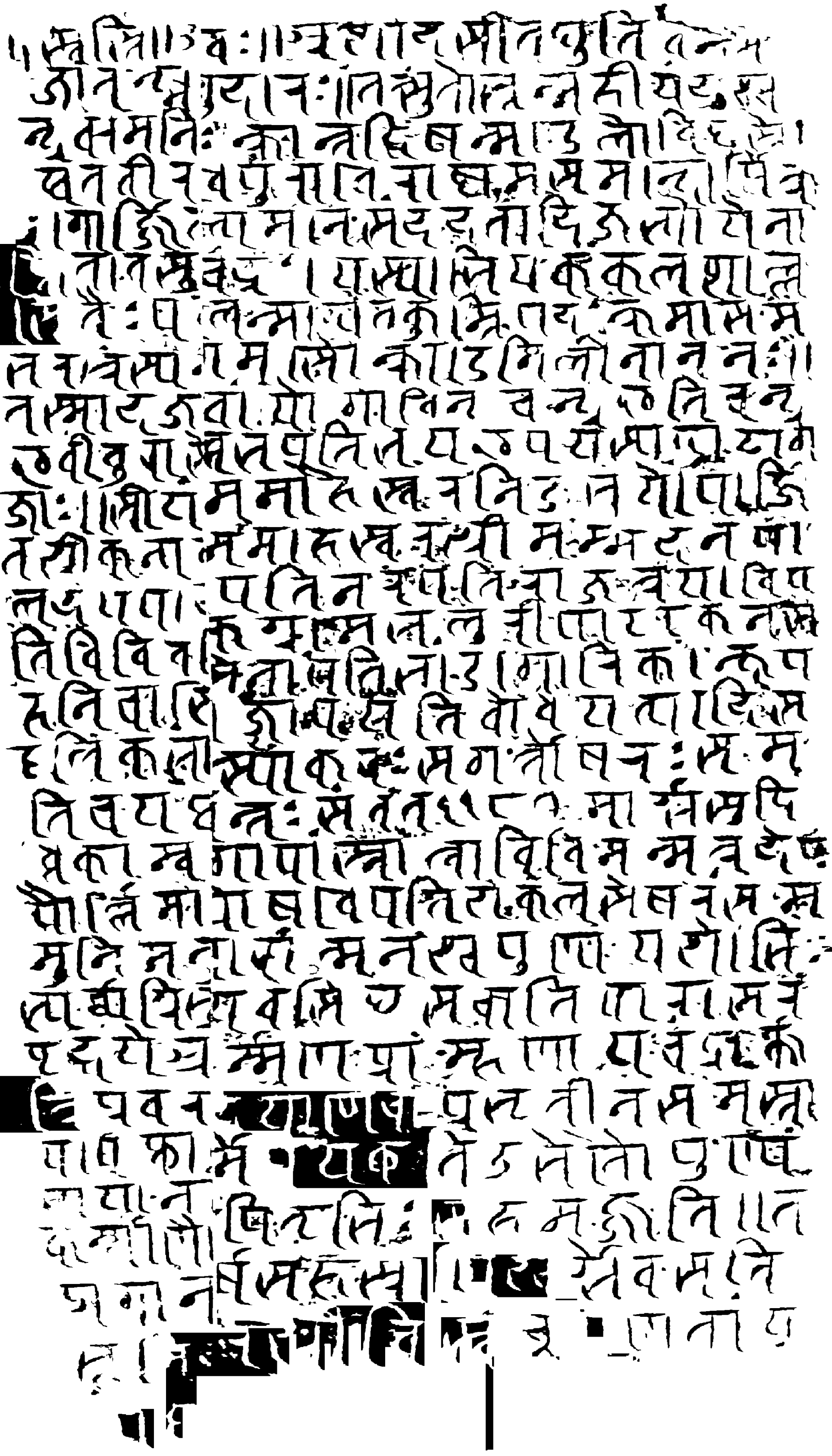
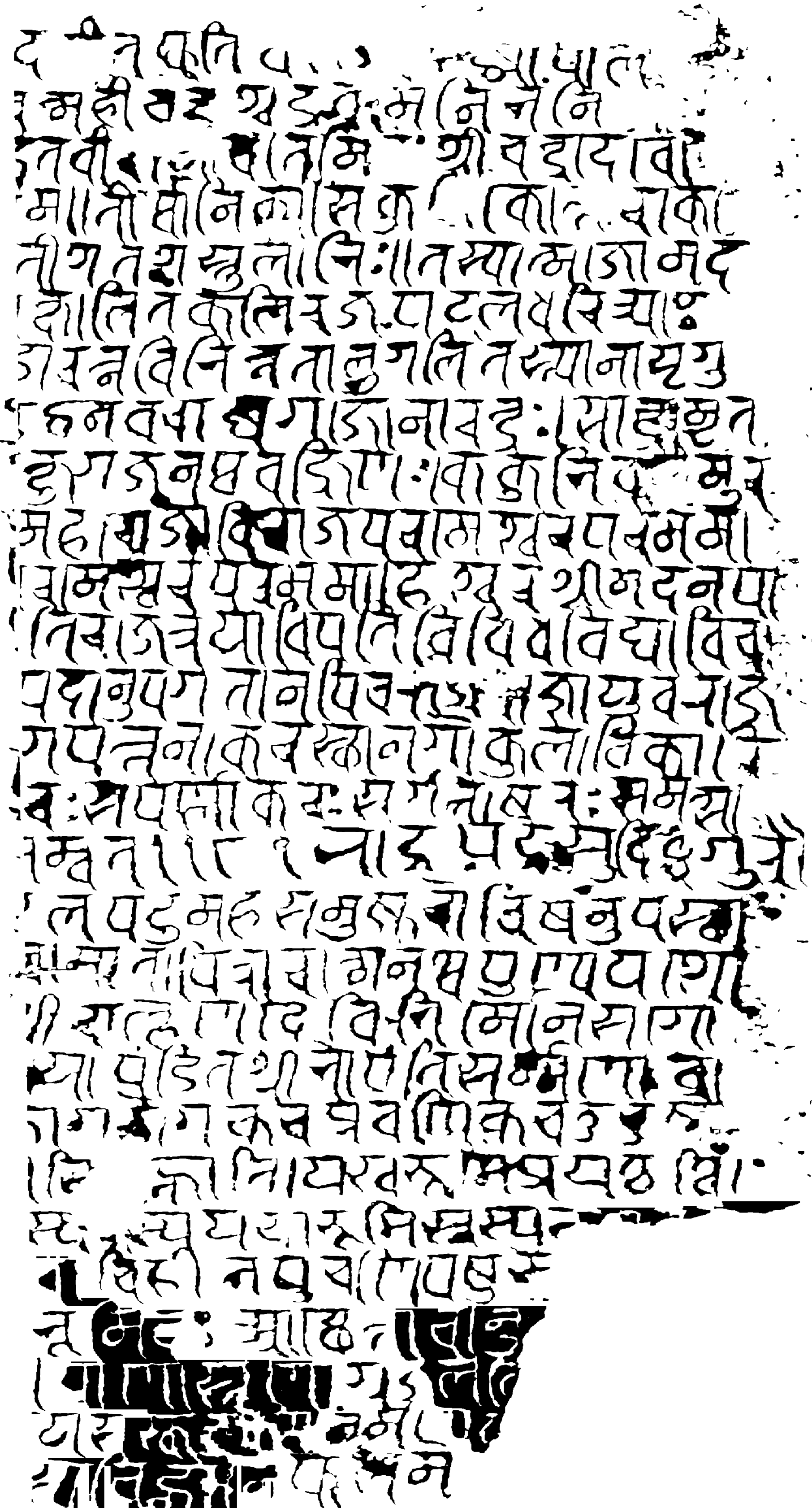


PLATE VII.



LIST OF CONTRIBUTORS.

◆

Page

ATKINSON, E. T.;—*Notes on Indian* Rhynchota: Heteroptera No. 1, ... 22

————;—*Notes on Indian* Rhynchota: Heteroptera, No. 2, ... 145

BARCLAY, A.;—*A Descriptive List of the* Uredineæ *occurring in the Neighbourhood of Simla (Western Himalaya).* (Plates XII.—XV.), ... 350

BLANFORD, HENRY F.;—*On the Influence of Indian Forests on the Rainfall.* (With a Wood-cut), ... 1

CARPENTER, ALFRED;—*Natural History Notes from H. M.'s Indian Marine Survey Steamer* 'Investigator,' *Commander* ALFRED CARPENTER, *R. N., Commanding.* No. 7. *The Mean Temperature of the Deep Waters of the Bay of Bengal.* (Plate X.),... 230

ELSON, SAMUEL R.;—*On the changes observed in the Density of the Surface Sea-water, coincident with, and due to Aerial Disturbances, and consequent Alteration of Baric Pressure over adjacent Sea Areas: and on the Usefulness of a more exact measurement of the Specific Gravity of Sea-water: more specially with Reference to the Waters near and about the Hooghly River Pilot Station.* (Diagram—Plate IX.), ... 15

FOOTE, R. BRUCE;—*Notes on some recent Neolithic and Palæolithic Finds in South India.* (With a Map—Plate XI.), ... 259

GILES, G. M.;—*Natural History Notes from H. M.'s Indian Marine Survey Steamer* 'Investigator,' *Commander* ALFRED CARPENTER, *R. N., Commanding.* No. 6. *On Six new Amphipods from the Bay of Bengal.* (Plates III.—VIII.), ... 212

JONES, E. J.;—*Natural History Notes from H. M.'s Indian Marine Survey Steamer* 'Investigator,' *Commander* ALFRED CARPENTER, *R. N., Commanding.* No. 5. *On some Nodular Stones obtained by trawling off Colombo in* 675 *Fathoms of Water.* (Plate II), 209

KING, GEORGE;—*A second series of New Species of* Ficus *from New Guinea*, ... 61

————;—*On some New Species of* Ficus *from Sumatra*,... 65

————;—*On the Species of* Loranthus *indigenous to Perak*, 89

Page

MUKHOPADHYAY, ASUTOSH;—*On the Differential Equation of a Trajectory.* (With a Wood-cut), ... 116

———;—*On Monge's Differential Equation to all Conics,* 134

———;—*A Memoir on Plane Analytic Geometry.* (With three Wood-cuts), ... 288

SCULLY, J.;—*On the Mammals and Birds collected by* Captain C. E. YATE, C. S. I., *of the Afghan Boundary Commission,*...... 68

———;—*On the Effects produced by Small Quantities of Bismuth on the Ductility of Silver,*........ 121

———;—*On the* Chiroptera *of Nepal,* 233

SIMON, E.;—*E'tude sur les Arachnides de l'Asie méridionale faisant partie des collections de l'Indian Museum (Calcutta),* 101

———;—*E'tude sur les Arachnides de l'Asie méridionale faisant partie des collections de l'Indian Museum (Calcutta),* 282

WOOD-MASON, J.;—*Natural History Notes from H. M.'s Indian Marine Survey Steamer* 'Investigator,' *Commander* ALFRED CARPENTER, *R., N. Commanding.* No. 4. *Description of a new Species of* Crustacea *belonging to the Brachyurous Family* Raninidæ. (Plate I.), ... 206

———;—*Natural History Notes from H. M.'s Indian Marine Survey Steamer* 'Investigator,' *Commander* ALFRED CARPENTER, *R. N., Commanding.* No. 8. *Description of a new Species of the Brachyurous Genus* Lyreidus *from the Depths of the Andaman Sea,* 376

Dates of issue of the different numbers of the Journal, Part II, 1887.

No. I.—Containing pp. 1—120, with Plate IX, was issued on July 23rd, 1887.

No. II.—Containing pp. 121—232, with Plates I, II, III, IV, V, VI, VII, & VIII, was issued on November 2nd, 1887.

No. III.—Containing pp. 233—349, with Plates X & XI, was issued on January 30th, 1888.

No. IV.—Containing pp. 349—376, with Plates XII, XIII, XIV, & XV, was issued on March 18th, 1888.

No. V.—Containing Title-page, Index, &c., to the Volume.

LIST OF PLATES.

I. *Lyreidus channeri.*
II. Barium nodules from 675 fathoms off Colombo.
III. *Phronima bucephala* and *Phronimella hippocephala.*
IV. *Rhabdosoma investigatoris.*
V. *Amphipronoë longicornuta.*
VI. *Lestrigonus bengalensis.*
VII. " "
VIII. *Eurystheus hirsutus.*
IX. Diagram for Corrections for Temperature of Fresh Water.
X. Chart shewing Mean Temperature of the Deep Waters of the Bay of Bengal.
XI. Map of South India shewing the chief localities at which Neolithic and Palæolithic Remains have been found.
XII. XIII. XIV. XV. Uredineæ occurring in the Neighbourhood of Simla (Western Himalaya).

JOURNAL

OF THE

ASIATIC SOCIETY OF BENGAL.

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Part II.—NATURAL SCIENCE.

No. I.—1887.

I.—*On the Influence of Indian Forests on the Rainfall.*—*By* HENRY F. BLANFORD, F. R. S., *Meteorological Reporter to the Government of India.*

[Received Jan. 20th ;—Read Feb. 2nd, 1887.]

(With a Woodcut.)

The following paper is an extract from the yet unpublished manuscript of the second part of a paper on the Rainfall of India; the first part of which has already been issued as an official publication in the Indian Meteorological Memoirs. In consideration of the great economic importance of the subject treated of, and also with a view to encourage and assist further enquiries, whenever favourable opportunities may offer, it has seemed desirable to publish this discussion in an independent form, and in anticipation of its appearance in the Indian Meteorological Memoirs; where it will form but a small and subordinate part of a memoir dealing with a subject of much wider range.

In an instructive paper originally communicated to *Petermann's Mittesilungen*, and subsequently published in translation in the *Quarterly Journal of the Royal Meteorological Society*, M. Woeikoff appeals emphatically to the evidence afforded by the Indian rainfall registers, in support of his contention that the action of forests is to increase the rainfall of a country. His appeal is directed chiefly to the contrast afforded by the Assam rainfall with that of the Gangetic valley plain, in about the same latitude and the same distance from the sea; and he apparently attributes the great difference displayed by these two provinces, wholly or mainly, to the fact that, while the former is extensively covered with forest, the latter, up to the Terai, is a broad sheet of field cultivation.

In this view I am unable to coincide. Without denying or even questioning the effect of forests as one element of the result, the conclusion thus formulated seems to me far too sweeping. M. Woeikoff considers, and I think rightly, the action of forests in enhancing the rainfall to be twofold. Firstly, they help to store water, by protecting the soil, and to keep up a constant evaporation; and secondly, by checking and obstructing the movement of the wind, they prevent the evaporated vapour being carried away, and tend to produce that calm state of the atmosphere that is favourable to ascending currents and local precipitation. But swamps, such as occupy large tracts of the Assam valley, and the numerous broad river channels that intersect it, must contribute a not unimportant quota to the vapour constituent of the local atmosphere; and the comparative stagnation of the air in the Assam valleys and the exclusion of those dry westerly winds which play so important a part in the meteorology of the Gangetic plain are certainly due, in far larger measure, to the fencing in of the Assam valley by the Patkoi, Naga, Khasi, and Garo hills, and, as regards Upper Assam, to the interception of westerly currents by the mid-valley obstruction of the Mekhir hills, than to any retardation of wind movement that can be effected by the forests. Furthermore, the action of the surrounding hills in setting up a diurnal convection of the humid-atmosphere, and its consequent dynamic cooling and precipitation, an action which also takes place in the much less humid hill tracts of the peninsula, is a very important item in the causes which contribute to produce the heavy spring rainfall of Assam; a precipitation not very greatly inferior to that of the summer monsoon. The other or passive effect of hills in enhancing rainfall, namely, the forced ascent of horizontal air currents, is less important in Upper Assam (the tract more particularly referred to by M. Woeikoff), although exhibited by the southern face of the Khasi hills, overlooking Sylhet, in a degree without parallel elsewhere in the world. But to the other causes above specified must certainly be attributed by far the larger part of that prevailing high humidity and copious rainfall which foster the exuberant vegetation of the province; rendering it, in the rich variety of its flora and its prolific insect life, comparable with the teeming productiveness of the Malay region.

The difficulty so conspicuously illustrated in the foregoing example, namely, of disentangling the combined effects of a number of causes all favourable to increased rainfall or the reverse, is one which renders it almost hopeless to seek for decisive evidence of the influence of forests by any comparison of the rainfall of different provinces, or of areas sufficiently large to display the contrasted effects in a striking and convincing manner. The best and perhaps only satisfactory kind of evidence, were it obtainable, would be the comparison of the rainfall of one and the same tract (one of at least some hundreds of square miles in extent) for many years, first while covered with forest, and again for many years after clearing. It is, however, not until a tract of virgin forest has been brought under the destructive operation of civilizing agencies, that, as a general rule, any attempt is made to record its rainfall; and when, therefore, the conditions necessary to obtain one term of the comparison are rapidly disappearing. The reversal of this order of things, the conversion of bare or at least partially wasted tracts into protected forest, is one, however, of which India already furnishes some examples, and with the progress of forest protection may yet furnish more; and if due advantage be taken of these as they present themselves, it may yet be possible to obtain rainfall data which may afford valuable and indeed practically onclusive evidence on the point in question, even if not fulfilling in all respects the rigorous conditions of the logical method of differences.

One instance of the kind, on a scale large enough for all reasonable demand, has lately been brought to my notice by Mr. Ribbentrop, and has been quoted in my Report on the Administration of the Meteorological Department in 1885-86; and despite some shortcomings in the due verification of the data it furnishes, shortcomings which it is now impossible to make good, it will probably, in the course of some years, as nearly fulfil the conditions of a test case as we are likely to attain to in an experiment of such magnitude. In some respects, indeed, the circumstances of this case are unusually favourable. The vicissitudes of the rainfall of the Central Provinces are smaller, proportionally, than those of any other province of an equally moderate average, and of the 22 stations, the rainfall registers of which will be brought in evidence, not less than 10 are regular meteorological observatories, working under the Meteorological Department of the Government of India.

The region referred to in the 1st part of my Memoir on the Rainfall of India as the Central Provinces south, has been described as a hilly and jungle clad country, including some extensive fertile plains, especially that which surrounds Raipur. The northern portion consists of the range of broken tablelands and hills here spoken of as the Satpuras, and these are largely clothed with forest. According to the most recent report of the Officiating Inspector General of Forests, the area of forest in the Central Provinces is estimated at 54,600 square miles, of which about nine-tenths are either in or to the south of the Satpura range. The area of the Central Provinces south is about 61,000 square miles. Hence about five-sixths of the whole are under forest. Now, prior to the year 1875, these forests were systematically wasted by the destructive method of cultivation practised by the hill tribes of Gondwana, as of other wild tracts in India and Burma. It is known under various local names, such as *Kumri*, or in the Central Provinces *dáhya* cultivation, and is thus described by Dr. Brandis: "A few acres of forest are felled one year, the wood is burnt and a crop of grain raised on the clearing; the next year this is abandoned, a fresh piece of forest is felled elsewhere, a crop is raised, and it too is abandoned in its turn; and so on, a fresh clearing being made every year."

It will be readily understood how under such a system, in the course of some years, extensive forests may be devastated, even by a sparse hill population of nomad habits. And accordingly, in the introduction of the Central Provinces Gazetteer, published in 1870, Mr. C. Grant speaks of the state of the forests in the following terms: "The tree forests of the Central Provinces have, however, been so much exhausted, mainly owing to the destructive *dáhya* system of cultivation practised by the hill tribes, that, except in one or two localities, the labours of the Forest Officers will, for many years, be limited to guarding against further damage, and thus allowing the forests to recover themselves by rest. By far the greater part of the uncultivated lands belonging to Government are stony wastes, incapable of producing a strong straight growth of timber."

In 1875,* the suppression of *dáhya* cultivation was taken systematically in hand, and in the course of a few years, with such success, that Mr. Ribbentrop writes in 1886, "My attention was directed during a recent visit to the Central Provinces, to the extensive growth of young forests in areas formerly under *Kumri* cultivation. Ten or fifteen years ago, such temporary cultivation was practised throughout the country, and thousands of square miles were thereby laid barren year after year. Since then, this method of cultivation was stopped, and though a great part of the area affected was subject to annual fires, a more or less dense forest growth has sprung up. I concluded that this must have had an influence on the rainfall, sufficiently appreciable to be gauged by meteorological records. The results gathered from such records are beyond expectation and shew that, with the exception of stations situated in the cultivated valley of the Nerbudda, a steady increase of rainfall has taken place during the last ten years, and, as might be expected, especially during the last period of five years."

---

* I understand from Mr. C. E. Elliott who worked as Settlement Officer in the Central Provinces prior to 1875, that endeavours were then in progress to check *dáhya* cultivation, so that the statement in the text which I make on the authority of Mr. Ribbentrop must not be taken as rigorously exclusive. The interpretation of the evidence here adduced will not, however be appreciably affected by this correction.

In dealing with the evidence of the rainfall registers, I shall, in the first place, compare the averages of the 9 or in some cases 10 or 11 years ending with 1875 (the year in which the suppression of the *dáhya* cultivation is stated to have been taken in hand) with those of the ten subsequent years, 1876—1885; and this I shall do separately for the stations within the area immediately affected by the forest preservation and for those at a greater or less distance therefrom. These latter are Saugor and Damoh, the forests near which have not been frequented by *dáhya* cultivators, or which are surrounded by native states in which no change of system has been attempted, Jubbulpore, Narsinghpur, Hoshangabad, and Khandwa in the fertile and highly cultivated valley of the Nerbudda, and where the tendency of late years has been towards an extension of permanent cultivation, and Raipur in the centre of the great wheat-growing district of Chattisgarh.

Comparison of the Average Rainfall of 9 *to* 11 *years of Dáhya Cultivation with that of* 10 *years of Protected Forests.*

A. In affected areas.

STATIONS.	Forests unprotected.		Forests protected.		Increase.
	Period.	Inches Rain-fall.	Period.	Inches Rain-fall.	Inches.
Badnur	1867-75	39·83	1876-85	47·83	+ 8·00
Chhindwara	1865-75	41·43	1876-85	48·48	+ 7·05
Seoni	1865-75	52·07	1876-85	54·76	+ 2·69
Mandla	1867-75	53·58	1876-85	56·32	+ 2·74
Burha	1867-75	64·51	1876-85	71·65	+ 7·14
Bilaspur	1865-75	41·85	1876-85	54·81	+12·96
Sambalpur	1867-75	54·80	1876-85	67·93	+13·13
Dhamtari	1867-75	48·83	1876-85	46·90	— 1·93
Bhandara	1867-75	49·90	1876-85	57·79	+ 7·89
Nagpur	1866-75	41·54	1876-85	51·85	+10·31
Wardha	1866-75	36·10	1876-85	46·63	+10·53
Brahmapuri	1867-75	53·95	1876-85	57·48	+ 3·53
Chanda	1866-75	47·14	1876-85	54·29	+ 7·15
Sironcha	1867-75	44·17	1876-85	48·38	+ 4·21
				Mean	+ 6·81

B. In unaffected areas.

Saugor	1866-75	55·97	1876-85	40·62	—15·35
Damoh	1867-75	54·76	1876-85	46·82	— 7·94
Jubbulpore	1866-75	60·66	1876-85	56·28	— 4·38
Narsinghpur	1866-75	55·46	1876-85	50·40	— 5·06
Hoshangabad	1866-75	47·08	1876-85	57·73	+10·65
Khandwa	1867-75	34·74	1876-85	33·32	— 1·42
Raipur	1866-75	51·59	1876-85	54·47	+ 2·92
				Mean	— 2·94

The contrast, thus shewn, is sufficiently striking; but taken as they stand, it can hardly be said that the figures do more than afford a certain presumption in favour of the view that the difference shewn by the two series of stations is to be attributed to the preservation of the forests. In the first place, as I shall shew elsewhere, the probable error of a ten years' rainfall average of a station in the Central Provinces is about 5 per cent., and this may be either in excess or defect. In the extreme case of the errors being in opposite directions in the two decennial periods compared, the greater part of the apparent increase of list A would vanish. And, in the second place, the majority of the stations in the second list lie to the north of the Satpura range, those of the first list either on the range itself or to the south of it; and, as this range about coincides with the southern margin of the tract commonly followed by the cyclonic storms of the summer monsoon, the distribution of the rainfall might be much affected by the fact of a series of such storms following a more southerly or more northerly path, or by the western branch of the monsoon, which brings nearly the whole rainfall to the region south of the Nerbudda valley, being in several years, relatively to its normal average, stronger and more rainy than the eastern branch, which contributes to the rainfall north of that river.

But there is another way of dealing with the facts which will not be open to such objection. Any effect really due to forest protection must necessarily have been progressive. Some few years were passed in inducing the jungle tribes to take to settled cultivation; again, the reproduction of the forest growth on the tracts formerly denuded is a process requiring many years for its accomplishment; and, finally, the protection of the forests from destruction by annual fires in the dry season has been steadily extended year by year. If, then, it should appear, on comparing the rainfall of the affected tract in successive years, that the increase has been steadily progressive and on the whole in a degree commensurate with the average difference of the two decennial periods above compared, the probability of such increase having been brought about by the protection of the forests will be enormously enhanced.

The data for this comparison are afforded by the following table which exhibits, in the second column, the mean rainfall of the 14 stations, enumerated in the A list of the previous table, in each year from 1867 to 1885. The third column gives what may be termed progressive averages. Each average is that of 5 years, obtained by the formula,

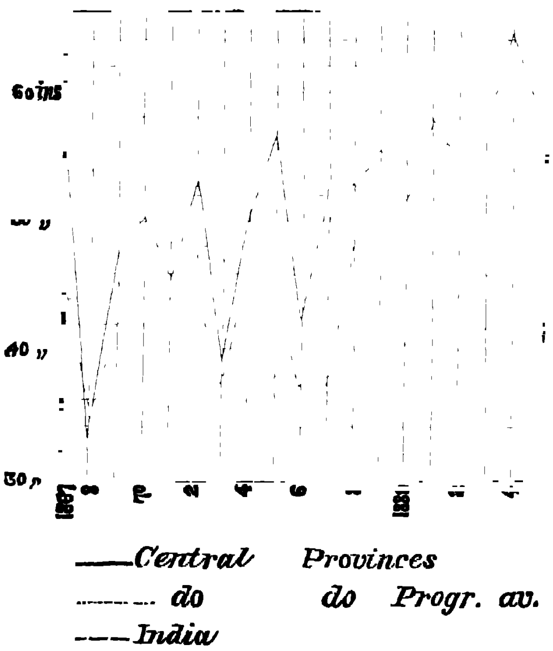
$$c_{,} = \frac{+ 4b + 6c + 4d + e}{16}$$

wherein a, b, c, d, e, represent the mean rainfall in any five concecutive years and $c_{,}$ the progressive average for the third year of the series. As a standard of comparison, I give, in the fourth column, the average rainfall of the whole Indian area (with the omission of unrepresented tracts). The average rainfall is taken at 42 inches. Lastly, the fifth column shews the progressive averages of the rainfall of India computed from column four.

Comparative Table of the Mean Annual Rainfall of the Forest Region in the Central Provinces and of India from 1867 *to* 1885.

Year.	Condition.	Central Provinces.		India	
		Annual mean Inches.	Progressive average. Inches.	Annual mean. Inches.	Progressive average. Inches.
1867	Under dáhya	55·08	......	44·8	40·2
68		33·59	......	35·4	40·3
69		47·97	45·28	42·4	41·0
70		50·42	47·71	43·5	42·6
71		45·52	48·45	42·9	43·0
72		53·31	47·47	44·3	41·7
73		39·18	47·02	37·5	42·2
74		50·48	48·85	46·6	42·4
75		56·60	50·15	44·4	42·4
76		42·32	49·58	37·5	40·5
77	×	52·50	50·40	37·7	41·1
78	Protected	52·47	52·60	48·3	43·3
79		55·67	53·85	43·7	43·5
80		51·83	54·50	40·4	42·4
81		57·90	55·31	42·1	42·4
82		54·22	56·52	44·6	43·0
83		57·73	58·57	41·9	43·1
84		64·63	......	43·7	......
85		57·43	......	43·1	......

The variations exhibited in this table are represented graphically in the following figure.



Now the third column of this table shews, not only that the increased rainfall of the protected forest region has been on the whole progressive since 1876 (the year after protection was systematically enforced), but that its progression has been commensurate with the increase of the decennial average shewn in the previous table; a very important point. As compared with the general average of the period antecedent to 1875, a rainfall of 48 inches, in integral figures, had risen to 58 inches in 1883, an increase of more than 20 per cent. Whether this increase will be sustained at its full amount by the results of future years is, however, very questionable. The rainfall of 1884 was extraordinarily high, and whereas, as may be observed in the graphic representation of these changes, the rainfall of the Central Provinces rises and falls *pari passu* with that of the whole of India in a somewhat remarkable degree (having regard to the comparative smallness of its area), the progressive average rainfall of India as a whole for 1883 was nearly 3 per cent. above the general average between 1867 and 1875. But after making all due allowances, in so far as any legitimate conclusion can be drawn from the experience of the last ten years, it would seem that, owing to some local cause, the mean rainfall of the afforested region of the Central Provinces here considered, an area of nearly

50,000 square miles, has been increased in a very remarkable degree, and I am unable to assign any other probable cause for this than that of the protection and consequent restoration of the formerly wasted forests.

The evidence thus afforded in favour of the influence of forests on rainfall appears to me to be of considerable weight and importance, in virtue both of the magnitude of the area yielding it and of the apparent distinctness of the result. With one exception and one only, it fulfils all the conditions of a rigorous test case. The area is one and the same; the history of the changes to which it has been subject are definitely and accurately known; and, as will be shewn elsewhere, the rainfall registers, if but few in proportion to the area, are sufficient to afford a datum the probable error of which is small in comparison with the magnitude of the effect shewn. The only remaining points to which exception may conceivably be taken are the trustworthiness of the records used, and the sufficiency of the periods compared to yield valid averages.

On the first of these points, I can add but little to what has been already written in the introduction of Vol. III, Part I, of the Indian Meteorological Memoirs. Speaking from recollection (for I have been unable to obtain the desired verification of the fact from official records), I believe that new rain-gauges, of Glaisher's pattern, from one of the principal London makers, were furnished to all the stations the registers of which are here dealt with, about the year 1867, at all events before 1870, that is to say, at or near the beginning of the period for which the registers are complete, and there are therefore no grounds for suspecting that the increase of the registered rainfall during the last ten years has been influenced by a change in the instruments used. And this is the most important consideration. With respect to the registering agency, as far as I have information, it has been the same throughout. Dr. S. C. Townshend, who was Sanitary Commissioner of the Central Provinces, and who in 1868 established the observatories, which, in 1875, were incorporated in the Imperial system, took much personal interest in all the meteorological work of the province, and there is no doubt that his action was attended with beneficial results. But this change, like that of the instruments, dates from the beginning of the period now under consideration; at all events from 7 or 8 years anterior to 1875.

On the second point, namely, the sufficiency of the periods compared to yield valid averages, I have ascertained that a ten years' register of the Central Provinces' stations, Jubbulpore and Nagpur, has a probable error of 5 per cent., namely, in the case of Jubbulpore of 2·7 inches, in that of Nagpur of 2·2 inches, and these may be taken as fairly illustrative examples of the whole province. These, however, are the probable errors of individual stations, and, as will be further demonstrated elsewhere, the mean rainfall of a whole province is much less variable than that of a single station. For, if we take the average of either the first ten years or the last ten years of the figures in the third column of the table, on page 7, we have an average of 1867—1876, 47·45 ins. probable error ± 1·56; average of 1876—1885, 54·67 ins. probable-error ± 1·22, which is but little more than half the probable error of either Jubbulpore or Nagpur for an equal period. This is small in comparison with the difference of the two averages, namely, 7·22 inches. Assuming the extreme case, that the first average is 1·56 inches below the real mean and the second 1·22 inches about it, these differences being both due to fortuitous and not steadily progressive causes, there would still remain 4·44 inches of increase unaccounted for. This is perhaps not such as to warrant conviction that the average rainfall of the Central Provinces south of the Nerbudda has really increased by that amount; still less does it warrant the positive assertion that such increase, assumed as real, is due to the preservation of the forests; but at least, in so far as any inference is admissible from such data, the evidence seems to afford much support to that view.

Direct observations of a character similar to those of Prof. Ebermeyer in Bavaria, namely, comparative measurements of the rainfall at pairs of stations near the margin of forests, the one within, the other without the forest, have been carried on in Dehra Dún and Ajmere, during the last year or two, by officers of the Forest Department. Some of the results of these were given in the Administration Report of the Meteorological Department for 1885—86, and I have since visited the Dehra Dún stations and some of those in Ajmere. In the case of the former, the conditions are satisfactory, in so far that the forest on the site of the observatories is a vigorous growth of chiefly Sál coppice* with a well-defined boundary, and the observatory stations are, in the one case, well within the forest, in an opening only just large enough to prevent the gauge being sheltered, or its contents unduly added to by the drip of the trees; in the other, in an open maidan of coarse grass and scrub, with only a rare tree here and there. But the interval between the two stations of each pair is hardly enough to shew the full influence of forest in the one case, or to exclude it in the other; and it can only be expected that, under such circumstances, any difference depending on that influence will be very small.

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* As testifying to the importance of this condition, I extract the following from a letter lately received from Dr. D. Brandis, for many years Inspector-General of Forests in India; "I would draw your attention to a point which I used to urge in India, whenever I wrote on the subject; *viz.*, that forests, in order to exercise an effect (on the rainfall), must be dense, and must not consist of a few bushes and trees, here and there. Fire protection alone has the effect of making the forest grow up dense, and I am disposed to think that the large extent of fire protected forest in the Central Provinces may, in course of time, affect the rainfall."

There are two such pairs within about 6 miles of Dehra Dún, on the skirts of the Sivalik forests, the one at the Ramgarh, the other at the Rajah's forest. In the case of the Ramgarh forest, at which the observatories have been longest in existence, the two observatories are 750 yards apart; the outer 400 yards from the forest boundary, the inner 350 yards from it. At each station, there are two rain-gauges, the one on the ground, the other at a height of 60 feet, being perched on the summit of a scaffold, which raises it above the tops of the neighbouring trees. The rain-gauges are Symon's pattern, 5 inches in diameter, and the measurements are all made with the same measure glass. The observer has been regularly trained in his duties (which include keeping 4 registers of temperature and humidity, under corresponding conditions), and his work seems to have been regularly performed. The results for the years 1884 and 1885 are given in the following table:—

Months.	Lower gauges.			Upper gauges.		
	Outer.	Inner.	Diff. I—O	Outer.	Inner.	Diff. I—O
June 1884	3·66	4·07	+ 0·41	3·61	3·88	+ 0·27
July "	25·64	26·46	+ 0·82	24·72	26·44	+ 1·72
August "	21·18	21·74	+ 0·56	19·88	21·23	+ 1·35
September "	17·53	18·78	+ 1·25	17·19	18·01	+ 0·82
October "	0·28	0·39	+ 0·11	0·26	0·37	+ 0·11
November "	0	0	0	0	0	0
December "	0	0	0	0	0	0
Total ...	68·29	71·44	+ 3·15	65·66	69·63	+ 4·27
January 1885	4·20	4·48	+ 0·28	4·56	4·63	+ 0·07
February "	0·85	0·70	— 0·15	0·77	0·67	— 0·10
March "	0·48	0·39	— 0·09	0·42	0·36	— 0·06
April "	0·44	0·55	+ 0·11	0·45	0·50	+ 0·05
May "	5·35	5·99	+ 0·64	5·06	5·79	+ 0·73
June "	10·31	10·76	+ 0·45	9·75	10·61	+ 0·86
July "	9·81	9·90	+ 0·09	9·27	9·88	+ 0·61
August "	44·64	44·91	+ 0·27	43·56	44·45	+ 0·89
September "	6·24	5·51	— 0·73	6·06	5·47	— 0·59
October "	0	0	0	0	0	0
November "	0	0	0	0	0	0
December "	3·45	3·49	+ 0·04	3·48	3·52	+ 0·04
Total ...	85·77	86·88	+ 0·91	83·38	85·88	+ 2·50

The observations at the Rajah's forest extend over a shorter period. The stations are less than a mile distant from the former, and the arrangements are similar; the surrounding conditions of each of the pair being being strongly contrasted. The outer observatory is 1,750 yards from the forest boundary, the inner 1,000 within the forest, which is of the same character as the Ramgarh forest.

Months.		Lower Gauges.			Upper Gauges.	
	Outer.	Inner.	Diff. I—O	Outer.	Inner.	Diff. I O
March 1885	P	0·27	P	0·21	0·23	+0·02
April "	0·06	0·42	+0·36	0·32	0·36	+0·04
May "	4·69	3·99	—0·70	4·36	4·04	—0·32
June "	10·47	11·70	+1·23	10·07	11·42	+1·35
July "	9·81	10·63	+0·82	9·47	9·88	+0·41
August "	47·50	45·87	—1·63	46·99	45·87	—1·12
September "	2·43	2·46	+0·03	2·40	2·41	+0·01
October "	0	0	0	0	0	0
November "	0	0	0	0	0	0
December "	3·40	3·54	+0·14	3·43	3·45	+0·02
Total ...	78·36	78·88	+0·25	77·25	77·66	+0·41

In this case, while, in most months, the rainfall at the inner station is appreciably higher than at the outer station, as shewn both by the elevated and ground level gauges, this gross excess appears to have been nearly neutralized by falls in May and August, which were in excess at the outer station. The result of the evidence is therefore doubtful. But in the case of the Ramgarh station there does appear to be a decided balance of rainfall in favour of the inner station.

I do not give the results of the Ajmere observations, because the difference of the conditions within and without the boundary of the forest, as far as I have seen them, depend much more on the form and slope of the ground than on the density of the forest growth, and I do not think the comparative observations have much bearing on the question at issue.

There remains one case which, although dependant on purely artificial conditions, might yet afford evidence of some weight in connection with the present subject, could we only be sure that the observations had been taken with the care and precaution indispensible to any valid comparison.* In the very heart of the plain between the Ravi and the Jhelum (two of the five rivers of the Punjab), and about 50 miles to the south of Lahore, a vigorous forest has been established, by planting and irrigating the planted land from the Bari doab canal. The forest area covers 31⅔ square miles and has now been established 16 years.* Outside the forest and to the east and south-east are lands which are cultivated, also with irrigation from the canal; and on the margin of this tract, four miles from the forest, is the small civil station of Chunian. Since 1864, a rainfall register has been kept regularly at Vahn (within the forest, half a mile distant from the nearest forest boundary), and also at Chunian; and since 1870, a third register has been kept at Bhambeh, a station on the Bari doab canal, in a position very similar to Chunian, but 13 miles to the north-east of the forest boundary and 19 miles north-east from Ghanga Manga or Vahn.

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* For the following information I am indebted to Col. Home, R.E., late Secretary to the Punjab Government in the Irrigation Department of the Public

The rainfall chart of the Punjab shews that, in this part of the province, there is a steady increase of rainfall in a north-east direction or from Chunian to Bhambeh; steady, that is to say, apart from the influence of purely local conditions, and therefore, were the whole surface of the tract such as it is immediately around Chunian and Bhambeh, it might be anticipated that the mean rainfall of any intermediate station should be intermediate between those of Chunian and Bhambeh, in inverse proportion to their respective distances. The mean rainfall of Bhambeh, deduced from 17 years' registers, is 17·27 inches; that of Chunian, deduced from the same period, is 14·05 ins. If, then, Vahn, which is 19 miles from the former and 6½ miles from the latter station, had a rainfall intermediate between the

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Works and now Secretary to the Government of India. "Two gauges are placed side by side, the receivers are 4½ feet above the ground. One is an ordinary tube gauge, measurements made with a graduated rod. The other a Watsen's continuous self-registering gauge, which is taken to pieces, cleaned and re-adjusted on the 1st April yearly. The bearings of the gauge are silver plated copper tubes and with very ordinary care in adjustment, they register very correctly. Instructions about registering rainfall are very distinct and I believe they are obeyed."

* Mr. H. C. Hill, Conservator of Forests in the Punjab, writes, "Changa Manga is a compact block of 20,242 acres, of which 8,399 are wooded with planted Sissoo (*Dalbugia Sissoo*). The remainder is under ordinary scrub. The age of the plantation dates back to 1866-67, but little was done for 3 years and the age of the forest may be taken as 16 years. The trees (excepting those in the canal avenue averaging 63 feet) of our best compartments average 50, 51 and 53 feet in height and all compartments have an average of 40 or more."

"The watering of the forest begins in April and goes on more or less till September. Very little of it ever gets a second watering in the year, but that given is a good soaker of 3 or 4 feet depth of water. The ground to the east and south except where 2 *rahhs* are touched, is all under cultivation and irrigated. Irrigation mostly from June to April.

above amounts, in inverse proportion to the distances of the two stations, the average of the same 17 years would be 14·85 inches. It is actually 15·76 ins., or nearly 1 inch above the computed proportion.

I am far from considering this result as conclusive on the point at issue. In some years, the deviation from the mean proportions is very large, and the average of the last three years (which, in this part of the Punjab, have been characterized by a remarkably low rainfall) shows that the Vahn rainfall has been almost exactly in the inverse ratio of the relative distances of the two outer stations. Still, the evidence, so far as it goes, favours the idea that the *forest increases* the rainfall.

The general conclusion to be drawn from the facts set forth in the foregoing pages is that, while no one of the instances cited fulfils the requirements of scientific proof, the tendency of the evidence they afford is uniformly favourable to the idea that the presence of forest increases the rainfall.

The evidence is of three kinds. First, we have that of a large province some five-sixths of which have always been a forest wilderness, but in which, for the first ten years of the period of registration, the forest growth was greatly devastated; partly by *dáhya* cultivation, which completely destroyed the forest for the time being, whenever it was carried on, and partly by annual forest fires, which destroyed the under-growth and injured the larger trees. For the next ten years, these destructive operations were suppressed and the visible result is a forest growth of such vigour and luxuriance as to attract the attention of the Inspector-General, when on his tour of inspection, to the question of its probable effect on the rainfall. During these last ten years the rainfall of the province has progessively increased until it would appear to amount to 20 per cent. more than the average of the first ten years.

The second instance is that of two pairs of comparative observatories, established on the Ebermeyer plan, in near proximity to each other on the boundary of a protected forest; one of each pair being within, the other without the forest, on open ground. Notwithstanding their proximity, in most months the outer observatories shew a slight excess over the inner. At each observatory there are two gauges; one at 60 feet above the ground, the other on the ground; and both afford consistent results. In the case of one pair of observatories, the total of 18 months' register shew an excess in the inner high level gauge of 4 per cent., in the lower of two per cent. In the case of the other pair, the registers of 12 months only shew an inappreciable net difference of the totals, although, in most months, the forest-gauges shew a slightly enhanced fall.

Lastly, we have the case of a forest artificially produced by irrigation (during the two driest months of the year) in a region so dry that cultivation is rendered possible only by irrigation. Seventeen years' registers at a station within the forest shew an excess of 6 per cent. over the probable rainfall of that station, as computed from the registers of two stations, one of which is 4 miles, the other 13 miles distant from the forest, and both on the borders of the cultivation.

The evidence is, then, in kind, not rigorously conclusive, and it must be admitted that in no case has it been guarded by those special precautions which are demanded by strict scientific enquiry. But I have no reason to believe that it is not as trustworthy as observations made under the general supervision of intelligent and educated men usually are; and such as it is, it tends to support and confirm the conclusions drawn *a priori* from general physical considerations. It justifies, I think, at least, the view I have already expressed elsewhere, namely, that I can no longer regard the long suspected influence of forests on rainfall as a question of equally balanced probabilities.

II.—*On the Changes observed in the Density of the Surface Sea-water, coincident with, and due to Aerial Disturbances, and consequent Alteration of Baric Pressure over adjacent Sea Areas: and on the Usefulness of a more exact Measurement of the Specific Gravity of Sea-water: more especially with Reference to the Waters near, and about, the Hooghly River Pilot Station.—By* SAMUEL R. ELSON.

[Received March ;—Read February 2nd, 1887.]

(With Pl. IX.)

In a work which I published some years since, entitled 'The Hooghly Sandheads Sailing Directory,' on the strength of observations made with a small glass instrument, the stem of which was graduated to two thousandths only, I asserted, that the sea water at the Hooghly River Pilot Station contained more salt at low water than it did at high water. But this seeming paradox requires some slight modification, for, I have since then found, with a soda-water bottle hydrometer, which readily weighs the sixteenth of a thousandth of salt in the water, that, in every case, on the least tendency of the sea thereabouts to set to the westward, in response, as I suppose, to aerial disturbances which lessen the baric pressure over the sea area to the southward, the water shows at once a decrease in salinity, consequently, the relative degree of saltness between these westward flowing waters outside, and those situated under the lee of Saugor and Edmonstone Islands, and their continuations, as outlying, partially dry, sands, to the northwards, will be altered, as I shall presently endeavour to show.

As an instance out of many I have known of the suddenness of a change of this sort:—At 1·30 P. M. of the 10th of August last, I found the sea at the Pilot Station registered a specific gravity of 1·024: but only four days afterwards, at the same hour with regard to the tide, and almost in the same position, it was only $1{\cdot}013\frac{8}{16}$ or was $\cdot 010\frac{8}{16}$ less salt. But gradually, during these four days, a westward set of the sea hereabouts had got up, which steadily increased until it was running at the rate of two miles an hour or more, and, as is always the case, its presence was unmistakably announced by a rather sudden change in the colour and appearance of the sea (in fact, it was this marked change that induced me to test the water again), the water changing from a wholesome sea-green to a yellowish (but not muddy or turbid) hue, or of the colour of stagnant ditch, or tank water.

But, generally speaking, after the westward set has run for some time, this sickly looking water changes its appearance for the more natural green. And, so far as my limited and solitary observations go to show, the amount of salt increases as the westward set slackens. Therefore, these intermittent incursions of greater or less supplies of fresher water from, I suppose, the great easterly mouths of the Ganges, must be taken into consideration, when making comparisons as to the relative amounts of salt contained in the sea-water off, and in, the different parts of the outlet channels of the Hooghly and its estuary.

As I have said before, in a paper read before your Society some time back, entitled 'The Tides and Currents of the Hooghly &c., &c.,' none, or but very little, of the water from the river Hooghly can possibly reach the Pilot Station, situated as it is about 36 miles S. S. E. from Saugor Roads, seeing that, by the direction vessels ride when at anchor, in all the lower part of the river, from Mud Point to Saugor, the ebb tide sets S. W. and S. S. W. away towards Balasore Roads, or Bay, which is an extensive circular and shallow basin some 40 miles broad. Therefore, Saugor Island and its outlying, partially dry reef, called Saugor Sand, running down as it does over 22 miles S. S. E. from the tail end of Saugor Island, whilst the over-active sun's rays are copiously extracting vapour therefrom, must, and undoubtedly does, afford efficient shelter to the muddier and semi-opaque, and therefore, warmer water on its immediate westward side, from an early incursion of the above-mentioned drift of fresher waters, from the eastward, as, doubtless, the following serial observations, carefully taken for the purpose, show.

		Temperature.		Specific gravity.
		Air.	Water.	
une 18th, 1886	Saugor Roads (bound out)	84·5°	85·5°	1·023$\frac{14}{16}$
" 20th "	Eastern Channel Light. W. by N., 4 miles	85·4°	86°	1·018
" 21st "	Eastern Channel Light. North, 9 miles	85·5°	86·5°	1·021
" 22nd "	Intermediate Light (bound in)	...	86·5°	1·020$\frac{6}{16}$
" " "	Lower Gasper Light ...	...	86·5°	1·021
" " "	Upper Gasper Light ...	...	86·5°	1·023$\frac{2}{16}$
" " "	Saugor Roads ...	...	86·5°	1·023$\frac{4}{16}$

Note :—The Saugor Roads observation of the 18th was taken on the last quarter flood, and that of the 22nd on the last quarter ebb.

By this we have an accumulation of salt in Saugor Roads of ·005$\frac{4}{16}$ over and above what was found in the water at the Eastern Channel Light Station, thirty-six miles farther seawards, only a day or two previous. There was a set to the westward of the yellowish green water at the Sandheads, or Eastern Channel Light Station, on the 20th and 21st June, which would probably account for some of the above great differences in the relative specific gravity, though not for all. We also see by the above observations that at a distance of eight or nine miles dead to seaward of the above station, and well out in the 20 fathom line of soundings, there was an increase in the density of the sea water of ·003, this indicating that the induced lateral stream of fresher water from the eastward was not of necessity a very broad one: the reason of which I will attempt to explain further on, when I come to speak of the influence which the Swatch of no Ground doubtless has upon this westward set of the outside waters of the littoral. But even out there, we see the density did not exceed that of the sheltered muddy waters at the Lower Gasper Light Station, thirty-three miles farther north, and that it fell far short of that of Saugor Roads.

With reference to this very interesting question of the increased specific gravity of these inshore waters of the littoral during the dry months of the year, it is worthy of note that our late senior pilot, Mr. C. Smyth, used to say his long experience led him to believe that the reason vessels so seldom 'felt the ground,' or 'bumped,' in the Gasper Channel,—when their known draft of water, depth given by the charts, height of sea-surface above 'lowest low water,' or zero, as given by the tide table, and allowance for swell running, showed they had apparently not much water to spare under their keels,—was, that some sort of meeting of the tidal currents piled up the water, as it were, about this spot, on the ebb tide. He was evidently not far wrong in his surmises as to there being a *something* which assisted vessels to cross the Gasper bar in safety.

Ever anxious to learn something more of the causes of these *freaks*, as some would call them, of the currents at the Sandheads, and of the varying specific gravity of its waters, on the 13th of November last I gladly availed myself of an unexpected opportunity for further investigation by taking serial observations of the sea-surface temperature and density on some one line, or compass bearing, right off from the turbid water of the Pilot, or Eastern Channel Light Station, out into the deep blue sea of the Bay of Bengal. Nor, for my purpose, could it have occurred at a better time, with regard to the relative state of the weather, when going and returning, as will be seen. I went off S. E. towards Rangoon as acting special pilot in the B. I. S. N. Company's 6 *S. S. Sirsa* and, commencing at the Lower Saugor Sand buoy, which is about 5 miles farther inshore and towards the land than the Eastern Channel Light Vessel, I took observations with the bottle hydrometer, and thermometer, every two hours, with the following results:—

	Temperature.		Specific gravity
	Air.	Sea.	
November 13th, 1886 Noon, 2 miles S. W. from Lower Saugor Sand buoy ...	86°	83°	1·009$\frac{13}{16}$
At 2 P. M. 20 miles S. E. of E. C. Light Station	...	83·5°	1·009$\frac{6}{16}$
At 3·30 P. M. Passed through a frothy line of demarcation running E. and W. between light and dark green coloured water.			
At 4 P. M. 45 miles on same line ...	81°	83°	1·021$\frac{7}{16}$
At 5·30 P. M. 60 miles on same line ...		82°	1·022$\frac{11}{16}$
November 14th 6 30 A. M. 200 miles on same line or in 19° 80′ N. 91° 2′ E. ...	81°	83°	1·022$\frac{6}{16}$
At Noon 265 miles miles on same line ...	81°	81·5°	1.022$\frac{6}{16}$
At 5·30 P. M. 320 miles on same line ...	81°	82·5°	1·023$\frac{10}{16}$

On this outward trip the ordinary fine weather of the winter monsoon prevailed, following a rather heavy cyclonic disturbance down the bay: but on the return journey on the 20th, 21st, and 22nd of the same month there was a hard cyclone prevailing to the south, and then southwest of the Hooghly Pilot Station; and a strong set of the sea up along the eastern side and, I suppose, the centre of the Bay of Bengal, carrying the vessel I was on board of, the B. I. S. N. Company's

S. S. "*Nowshera,*" onwards to the N. W., some three or four miles an hour faster over the ground than her dead reckoning showed her to be going through the water, on her N. W. course towards the Pilot Station and Hooghly River Sandheads, even all the way from the Alguada Reef, and I found the following :—

	Temperature.		Specific gravity.
	Air.	Sea.	
November 22nd, 1886 7 A. M. Sea indigo. 55 miles S. E. of Eastern Channel Light Station	81°	83°	1·023$\frac{10}{16}$
Note :—This temperature accords with, and the specific gravity exceeds what we had found at a distance of 200 miles, when bound the other way, only eight days before.			
At 8·30 A. M. 14 miles S. E. of E. C. Light Vessel. Sea dark green	...	80·5°	1·022$\frac{3}{16}$
At 10·10 A. M. 2 miles N. N. E. of E. C. Light Vessel. 1st quarter ebb ...	79·5°	79·5°	1·016$\frac{2}{16}$
Note :—This gives a difference of — 3°·5 in temperature and of + 006$\frac{3}{16}$ in the specific gravity from what prevailed at, and near about the same spot, on the 13th inst. or only eight days before.			
At 11·30 A. M. at Intermediate Light Station. Half ebb	...	79·5°	1·013$\frac{7}{16}$
At 3 P. M. 2 miles above Saugor Light House S. W.	81°	81°	1·007

We will now take the observations which were made at a position near the Eastern Channel Light Station, and compare them, to show what changes of density and temperature of the sea are there due to these fitful changes and disturbances of weather in the bay, during this month of November last.

	Temperature.		Specific gravity.
	Air.	Sea.	
On the 31st October 1886, 2 miles N. E. of E. C. Light, and just previous to a cyclonic whirl in the Bay, with its usual precursory westward set of the sea at the Sandheads	84·5°	86·5°	1·015$\frac{5}{16}$

	Temperature.		Specific gravity.
	Air.	Sea.	
(After this I was absent from Sandheads until the 13th.)			
On 13th November 1886, in nearly same position, just after the cessation of the strong westward set caused by a cyclonic whirl down the Bay, and all was again quieted	86°	83°	$1{\cdot}009\frac{15}{16}$
On 22nd November, in same position, during a severe and widespread cyclonic disturbance farther down the Bay which had been some days in existence: and when a strong north westward set of the sea was pouring in towards this position from, and across, and most likely out of, the depths of the peculiar sub-marine ravine, or gut of deep, and (as Commander Carpenter has told us) cold water, called 'The Swatch of No Ground*	79·5°	79·5°	$1{\cdot}016\frac{9}{16}$

From the above, and what has been shown before, it seems the fresher water setting from the eastward, off and on, ever since the 31st of October (on the evening of which day the changed colour and appearance of the sea alongside led me to test it, and I found a slight diminution in its density, even then), or for half a month, was completely crowded out, as it were, by the last mentioned north-westward moving current of the 20th, 21st, and 22nd of November: which the *S. S. Nowshera's* log book furnishes ample proofs of; and, as a consequence, the salinity of the water at the station increased too, and probably, for a while, exceeded its normal: but, on this point, the few observations I have had opportunity to make and record will not permit me to write with that degree of assurance that I should like to do.

Maury says of the hydrometer:—'In the physical machinery of the universe there is no compensation to be found that is more exquisite or beautiful than that which, by means of this little instrument has been discovered in the sea between its salts, the air, and the sun: but Maury could hardly have meant the instrument commonly found on shipboard, which can only be guessed at, if read to less than the nearest ·002, but, if so, what an amount of really valuable information may be got out of an instrument, which, although a rough and rude one, is so much more exact: the one is as different from the other as was the old cross staff of Christopher Columbus' time from the double reflecting sextant of to-day. Our forefathers were content to find their vessel's position to the nearest two or three miles, but modern navigators are not satisfied unless they get it to the fraction of a mile.

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* For a description of which see paper by Commander Carpenter, R. N. (read before your Society some time back).

Doubtless, the energy which brings the waters up from the ever-frigid bed of the deep sea:—the energy of attraction and repulsion;—of contraction and expansion, or, of deadweight and buoyancy:—this energy of motion, under different states and circumstances, of the chemically suspended salt atoms, contained in each ocean drop, will yet be made to divulge its partially hidden and secret treasures to the practical scientist for the navigator's benefit: as has been the case with the latent energy of that other heat vehicle and prime motor of the hurricane blast, as well as of the gentle zephyr—the invisible water-vapour globule in the air strata aloft. All that is required is the aid of willing workers and their faithful records: for all the facts as set forth above, meagre as have been the opportunities for observing them, go far to prove that the hydrometer, when constructed to show minute aggregation, or segration of salt atoms in the water, must prove to be no mean aid to the sailor, more especially to the coasting navigator, since it is near coasts that the currents generally are more capricious, or disguised by others which have never been properly explained. It will aid him either as a monitor of his vessel's proximity to land; of her being caught in the toils of some abnormal current, which may be hurrying his vessel on to her destruction (as was nearly the case during the cyclone in the Bay of the 19th, 20th, 21st and 22nd of November last, with the ship "*Airlie*:" which vessel was found to have been driven by the storm-impelled current 140 miles to the N. W., out of her dead reckoning, right through the dangerous South Preparis Channel, and actually had an oyster shell washed up on to her deck); or its indications may be made even to warn the watchful shipmaster of the on-coming, though yet distant, cyclone; let alone its probable use to scientists, in more ways than one.

My instrument; a rather large soda-water bottle, when ballasted, or weighted, so as just to float with its wire pedestal (or support and cup or pan for weights) in water at a temperature of 95° (which is the warmest of any sea water), happens to have a fluid displacement, or, which is the same thing, weighs in air exactly 10,000 grains—a convenient figure for calculating the several counterbalancing weights by. The weights are made by dividing and subdividing 320 grains weight of copper wire: the whole 320 grains being, of course, equivalent to 1·032, or thirty-two thousandths—a figure far above any degree of saltness of sea water, but chosen on account of its convenience of divisability:—thus, the 320 grains of wire doubled, straightened out and cut, gives ·016, or sixteen one-thousandths: of which make sixteen coils, or loops to denote it, of one piece. The other piece doubled as before and cut gives ·008, and so on, until the one-sixteenth of a thousandth is arrived at,—a fraction which will be found to readily sink the bottle, or 'turn the scale' of this frictionless balance.

Below is added a diagram (Pl. IX) for corrections for temperature of fresh water; and a suitable table of corrections for temperature of sea water will be found in '*Maury's Physical Geography of the Sea*,' and in many other books of a like character, for those who like to seek out for themselves the "*exquisite and beautiful compensations*" which as a part of its machinery the sea salts provide in the physical economy of the Ocean.

III.—*Notes on Indian* Rhynchota: HETEROPTERA, No. 1.

By E. T. ATKINSON, B. A., PRESIDENT.

[Received and Read December 1, 1886.]

Order RHYNCHOTA, Burmeister.

Hemiptera, Linn.: *Rhyngota* Fabr.: *Proboscidea*, Scop.: *Dermaptera*, Retz.

Insects with an incomplete metamorphosis, not exhibiting the marked changes from larva to pupa and imago observable in the *Lepidoptera:* furnished with a mouth or rostrum which is fitted for piercing and sucking. The rostrum is usually 3—4-jointed and contains four seta that arise from the anterior portion of the lower surface of the head and represent the maxillæ and mandibles of other orders of insects. Antennæ with 3—5 joints, rarely more; the wings are usually four in number, but are sometimes abbreviated or altogether wanting.

Suborder HEMIPTERA, Latreille.

The first pair of wings (*hemelytra)* are horizontal, with the veins arranged differently from those of the second pair (*wings*), and usually comprise a basal coriaceous portion (*corium* and *clavus*), and a membranous portion (*membrane)* at the apex. This membrane is sometimes entirely absent. The wings are entirely membranous and are sometimes absent.

GYMNOCERATA, Fieber, Reuter.

Cimex, Linn.: *Cimicides*, Latr.: *Geocorisæ*, Latr.: *Geocores*, Burm., Dallas: *Aurocorisa*, Westw.: *Terrestria*, Leach: *Geocorisæ* and *Amphibicorisæ*, L. Dufour, Spin., Sahlb. et auct.

Antennæ exserted, at least as long as the head, joints without lateral processes: rostrum 3—4-jointed, rising from the anterior and usually the upper part of the head, at the base remote from the first pair of coxæ: feet not adapted for swimming: antennæ with 4—5 joints rarely with only three joints.

Fam. PENTATOMIDÆ, Kolenati.

Pentatoma, pt. Olivier, En. Méth. iv, p. 25 (1789): *Cimex*, pt. Fabr. Ent. Syst. iv, p. 79 (1794): *Scutati*, Burm. Handb. Ent. ii (i), p. 343 (1835): *Longiscuti*, Am. and Serv. Hist. Nat. Ins. Hém. p. 19 (1843): *Scutata*, Dallas, List Hom. i, p. 2 (1851): *Pentatomidæ*, Kolenati, Mel. Ent. iv, (1846): Stål, En. Hem. v, p. 3 (1876): *Pentatomida*, pt., Stål, Hem. Afric. i, p. 32 (1864).

Head very often clypeated, rostrum 4-jointed, inserted usually near the labrum towards the apex of the head, seldom towards the base of the head: antennæ with 4—5 joints, inserted on the lower side of the head below the lateral margins: scutellum very large, reaching at least the base of the membrane.

Subfam. PLATASPINA, Stål.

Enum. Hem. v, p. 3 (1876):—*Plataspidæ*, Dallas, List Hem. B. M. i p. 61 (1851): *Plataspidina*, Stål, Ofvers. K. V. A. Förh., p. 611 (1870): *Arthropteridæ*, Fieber, Eur. Hem. p. 27 (1861); *Arthropterida*, Stål, Hem. Afric. i, p. 1 (1864).

Head clypeated: rostrum 4-jointed, inserted towards the base of the head, remote from the source of the labrum: scutellum very large, covering the entire abdomen: hemelytra longer than the body, with the apical half folded inwards: longitudinal veins of membrane simple: tarsi 2-jointed, the first joint very short.

Genus TARICHEA, Stål.

A. S. E. F. (4 s.) v, p. 163 (1865): Stål, En. Hem. v, p. 6 (1876): Walker, Cat. Het. i, p. 10 (1867).

Body very broadly ovate, above very much convex, beneath somewhat flat: head clypeate, very broadly rounded before the eyes, juga contiguous before the tylus: eyes slightly transverse: ocelli more distant from each other than from the eyes: lateral margins of thorax roundly dilated: scutellum covering entire abdomen, abruptly amplified at the base: feet somewhat short (*Stål*).

1. TARICHEA NITENS, Dallas.

Plataspis nitens, Dallas, List Hem. i, p. 74 (1851).

Tarichea nitens, Stål, A. S. E. F. (4 s.) v, p. 163 (1865); En. Hem. v, p. 6 (1876): Walker, Cat. Het. i, p. 111 (1867).

♀. Above brassy, very smooth and shining, rather thickly and finely punctured: head, disc of abdomen, anus, sutures and stigmata, black: pectus dull black: eyes reddish: abdomen bright red, shining: legs bright orange-red: head beneath black with an orange spot in the middle of the base: rostrum pitchy red, with the basal joint orange-red: antennæ orange-red, with the two (?) apical joints black (*Dallas*). Body long 9½ mill.

Reported from N. India.

Genus CALACTA, Stål.

A. S. E. F. (4 s.) v, p. 163 (1866): En. Hem. v, p. 6 (1876).

Body very broadly ovate or oval, rather convex, flat beneath: head produced before the eyes, somewhat amplified forwards, truncated at the apex; juga contiguous before the middle; eyes transverse, oblique; ocelli almost twice as distant from each other as from the eyes: lateral margins of thorax roundly amplified, anterior angles produced to the apex of the head, rounded: scutellum covering the entire abdomen, not abruptly amplified at the base: costal margin of hemelytra, broadly lobate at the base: feet somewhat short (*Stål*).

2. CALACTA RUFO-NOTATA, Stål.

Calacta rufo-notata, Stål, A. S. E. F. (4 s.) v, p. 164 (1865); En. Hem. v, p. 6 (1876).

♂. Broadly oval, moderately convex, remotely and finely punctulate: disc of thorax and scutellum very finely punctulate: eyes rufous-piceous: small spots, one marginal near the posterior angles of the thorax, another on the basal lobe of the hemelytra, two marginal dorsal before the middle of the abdomen, sanguineous: tarsi weakly testaceous flavescent: anteocular part of the head hardly amplified forwards (*Stål*). Long, 6; broad 2¾ mill.

Reported from Siam.

Genus ONCYLASPIS, Stål.

Hem. Afric. i, p. 2 (1864); En. Hem. v. p. 4, 6 (1876).

Body depressed, rather strongly convex: head broad, slightly or moderately bending forwards; vertex about thrice broader than the eyes which are transverse, oblique, narrowed inwards, deeply immersed.

very slightly prominulous beyond the sides of the head: ocelli remote from the eyes: antennæ inserted in the middle or almost in the middle between the eyes and the rostrum, the first joint somewhat equal in length to the two following: pronotum about twice as broad as the head, anterior margin gradually rather strongly sinuated behind the entire head; anterior angles obtuse, distinct, not rounded: feet generally short: sixth ventral segment in ♀ produced forwards in an acute angle reaching the base of the fifth segment; forming anteriorly (in ♀) a less produced right or somewhat obtuse angle *(Stål)*.

Type, *P. ruficeps*, Dallas.

3. ONCYLASPIS RUFICEPS, Dallas.

Plataspis ruficeps, Dallas, List Hem. i, 73, (1851): Walker, Cat. Het. i, p. 110 (1867).

Oncylaspis ruficeps, Stål, En. Hem. v. p. 6 (1876).

♂, ♀. Above brassy black, shining, very finely punctured, with the head and the anterior angles of the thorax reddish brown: coriaceous portion of the hemelytra brown: membrane brownish, semitransparent, with dark brown veins. Body beneath reddish brown, shining, finely punctured; the anal apparatus and the middle of the disc of the abdomen, black: legs, antennæ and rostrum reddish brown, the latter rostrum with the tip pitchy *(Dallas)*. Body long 9—10 mill.

Reported from Burma, Tenasserim.

Genus POSEIDON, Vollenhoven.

Tijdschr. Ent. Ned. viii, p. 63 (1865).

Body elliptical, rather broader, a little tumid above, shining: head in the ♂, broad, anteriorly with three horns which are channeled, the lateral pair curved inwards in the ♀, the head is broad, semicircular, the juga unite at the tip of the tylus: antennæ inserted below the head, 5-jointed; the first very long, cylindrical, rather broad, the second very small, only one-eighth of the length of the first, the third neither so long nor so stout as the first, slightly clavate, the rest gradually decreasing in length and thickness: eyes pyriform, very distant; ocelli much nearer to each other than to the eyes: rostrum extending beyond the posterior coxæ, the second and third joints of equal length: lateral margins of pronotum arched: scutellum scarcely emarginate posteriorly in the ♂: venter flat, with, in ♀, a short longitudinal groove on the first segment: feet rather short and stout *(Voll.)*

4. POSEIDON MALAYANUS, Vollenhoven.

Poseidon malayanus, Voll., Tijds. Ent. Ned. viii, p. 64, t. 1, f. 3-5 (1865).

♂, ♀. Bronzed black above: eyes brownish-white: two spots and two lines encircling the tylus, these lines in the ♂ are in the middle of the median cephalic horn: two small spots near the anterior margin of the pronotum, a thin line along its entire lateral margin and two round spots on the scutellum near, and a fine line around, the anterior margin, orange: scutellum rather strongly and pronotum more weakly punctured, head smooth: hemelytra piceous-brown: antennæ weakly pilose, black, with the joints whitish: rostrum ferruginous: body beneath shining black, except pectus which is dull cinereous: each segment of the abdomen in the ♀ has two small orange spots on each side on the margin: feet black, tarsi brownish (*Voll.*). ♂, long, 15; ♀, long, 13 mill.

Reported from Malacca, India?

Genus BRACHYPLATYS, Boisduval.

Voy. Astrolabe, Ent. ii, p. 627 (1832): Westwood in Charlesworth's Mag. Nat. Hist. ii, p. 26 (1838); White, id., iii, p. 539 (1839): Dallas, List Hem. i, p. 61 (1851); Walker, Cat. Het. i, p. 98 (1867): Stål, Hem. Afric. i, p. 8 (1864); En. Hem. v, p. 4, 7 (1876):—Includes *Coptosoma*, subg. *Platycephala*, Lap., Ess. Hém, p. 74 (1832).

Body very broadly ovate, generally slightly convex above, flat beneath: head foliaceous, transverse, broad, broadly rounded at the apex; vertex 4-5 times broader than the eyes; antennæ remote from the eyes, the first joint not longer than the third, almost equal in length: eyes slightly transverse, not oblique, slightly immersed, strongly prominulous beyond the sides of the head, narrowed outwards: ocelli a little more distant from each other than from the eyes: pronotum about one half broader than the head, sinuated at the apex behind the vertex, truncated behind the eyes, anterior angles obtuse, rounded at the apex, not produced. As pointed out by Westwood, the scutellum in the ♂, in, both *Brachyplatys* and *Coptosoma*, is notched and in the ♀, entire. In the former the sixth ventral segment, in the ♂, is produced forwards in an acute angle reaching the base of the fifth segment, and in the ♀, forms anteriorly a less produced right or somewhat obtuse angle: in *Coptosoma*, the same segment forms an obtuse, or very obtuse angle, or is merely obtusely rounded. In *Brachyplatys*, the first joint of the last tarsi is nearly as long as the second, and in *Coptosoma* is much shorter.

5. BRACHYPLATYS VAHLII, Fabricius.

Cimex vahlii, Fabr. Mant. Ins. ii, p. 283 (1787) ; Ent. Syst. iv, p. 89 (1794) Coquebert, Ill. ii, p. 79, t. 18, f. 14 (1801) ; Wolff, Ic. Cim. p. 96, t. 9, f. 90 (1802) ?

Tetyra vahlii Fabr., Syst. Rhyng. p. 142 (1803).

Thyreocoris vahlii, var. Germar, Zeitsch. i (i) p. 33 (1839) ; Herr. Schäff. Wanz Ins. v. p. 31, 33 (1839).

Plataspis vahlii, Am. & Serv. Hist. Nat. Ins. Hém., p. 64 (1843).

Brachyplatys vahlii, Dallas, List Hem. i, p. 70 (1851) excl. syn. pt.; Walker, Cat. Het. i, p. 100 (1867) ; Stål. Ofvers K. V.-A. Förh. p. 611 (1870) ; En. Hem. v, p. 7 (1876) : Distant, A. M. N. H. (5s.) iii, p. 44 (1879).

Head, thorax, scutellum and abdomen, black : two large marks on the head, the margin of the thorax and a small oblique line before the margin, also the margin of the scutellum, flavescent : thorax gibbous, shining : two lines on each segment of the abdomen on both sides and which unite at the apex, also the feet, yellow *(C. vahlii*, Fabr.).

♂, ♀. Head with yellow transverse lines : pronotum with a sinuated transverse line on the anterior margin, abruptly curved before the anterior angle, before reaching the posterior angle ; an arcuate line on the border of each anterior angle and another similar intramarginal line around the scutellum, below which is another slender line ; margins of abdomen, transverse lines on each side of the venter, rostrum, feet and antennæ, yellow : some specimens have a small yellow dot on each side of the disc of the pronotum and another like it on each side at the base of the scutellum *(P. vahlii*, Am. and Serv.) Long 5-6 mill. Differs from *B. radians*, Voll., in its smaller size and having the intramarginal flavescent line on the scutellum punctured fuscous. Differs from *B. nigriventris*, Westw. in having transverse yellow lines on the head.

Reported from Philippines, Cochin-China, Assam : not uncommon in Sikkim.

6. BRACHYPLATYS RADIANS, Vollenhoven.

Brachyplatys radians, Voll., Faune Ent. l'Arch. Ind. Néerl. i, p. 52 (1863) : Walker, Cat. Het. iii, p. 527 (1868) : Stål, En. Hem. v, p. 8 (1876).

Var. *Brachyplatys vahlii*, Voll., l. c. p. 52 (1863).

Brassy-black : head spotted yellow ; anterior margin of thorax and oblique submarginal line yellow : two marginal lines on scutellum of which the interior line is the broader : venter yellow, with a large discal radiating patch (*Voll.*). Long 7 mill. Vollenhoven suggests that this is only a variety of his *B. vahlii.* It is a little larger : over almost the entire head extends a broad yellow patch in which winds a black streak that has its outline twice interrupted : the margin and yellow spots on the pronotum are broader and brighter : the venter black, with the yellow spots on the margin of a conical shape or it may be said that the venter is yellow with a broad black discal patch omitting rays towards the margin. Stål suggests that Vollenhoven's figure (l. c.) t. 4, f. 8 should be referred to this species: the yellow rays from the venter vary much in length and he has never seen specimens in which the small discoidal spots on the pronotum and the basal spots on the scutellum are wanting.

Reported from Philippines, Celebes, Sumatra, Amboina, Ternate, India (?).

7. BRACHYPLATYS SILPHOIDES, Fabricius.

Cimex silphoides, Fabr., Ent. Syst. iv, p. 86 (1794).

Tetyra silphoides, Fabr., Syst. Rhyng. p. 141 (1803): Schiödte in Kroyer's Nat. Tids. iv, p. 301 (1842), excl. syn. Burmeister.

Brachyplatys silphoides, Dallas, List Hem. i, p. 71 (1851), excl. syn. pt: Walker, Cat. Het. i, p. 100 (1867): Stål, Hem. Fabr. i, p. 5 (1868); En. Hem. v, p. 8, 1876).

Body entirely glabrous, brassy-black, immaculate: margin of abdomen broadly white with a row of black dots: wings lineated: feet yellow (*Fabr.*)

♂, ♀. Aenescent-black, very distinctly and rather densely punctured, head somewhat rugose, four small spots on head, lateral submarginal line and line obliquely drawn from lateral angles towards the interior part of the eyes and here confluent with the intramarginal line, also two small spots placed before the middle and very distant from each other, elevated margin of scutellum and intramarginal line, also four basal spots, yellow-testaceous: ventral limbus emitting on each segment two somewhat short flavescent rays of which the anterior is marked by a small black spot: feet flavescent (*Stål*). Long 6—8; broad, 5—6 mill.

Reported from India, Panjab, Ceylon, China. Westermann records its occurrence on rice (Serampore ?).

8. BRACHYPLATYS SUBÆNEUS, Westwood.

Plataspis subænea, Westw., in Hope Cat. Hem. i. p. 17 (1837).

Thyreocoris septus, Germar, Zeitschr. i (i) p. 32 (1839).

Brachyplatys subænea, Dallas, List Hem. i, p. 70 (1851): Vollenhoven, Faune Ent. l'Arch. Ind. Néerl. i, p. 54 (1863), excl. t. 4, f. 8: Walker. Cat. Het. i, p, 100 (1867): Stål, En. Hem. v, p. 8 (1876).

Brassy: head with a broad submarginal line and four dots on the rhombus (between the eyes), anterior and lateral margins of thorax and an angulated sublateral line and margin of scutellum, fulvous: feet palely luteous: abdomen brassy, marked by very many transverse conical spots on the sides (*Westw.*). Long 6¼ mill.

Reported from China, Philippines, Ceylon, Malacca, Burma, Assam, India.

9. BRACHYPLATYS BURMEISTERI, Distant.

Thyreocoris silphoides, Burm., Handb. ii (i) p. 384 (1835): Stål, En. Hem. v, p. 8 (1876).

Brachyplatys burmeisteri, Distant, A. M. N. H. (5s.) iii, p. 46 (1879).

Brassy-black: entire margin, the feet and marginal spots on the abdomen luteous (*Burm.*). Long 6-8 mill. Can be at once distinguished from *B. vahlii*, Fabr. and *B. silphoides*, Fabr. by its uniform coloration above and absence of luteous markings on the head and pronotum: the luteous abdominal radial streaks are as in *B. radians*, Voll.

Reported from Tranquebar, Noa-Dehing valley and Sadiya (Assam).

10. BRACHYPLATYS NITIDUS, Westwood.

Plataspis nitidus, Westw., in Hope Cat. Hem. i, p. 17 (1837); Walker, Cat. Het. i, p. 110 (1867).

Thyreocoris nitidus, Germar, Zeitschr. i (i) p. 35 (1839).

Brachyplatys nitidus, Stål, En. Hem. v. p. 9 (1876),

Altogether black, shining, finely punctured: head broad; scutellum posteriorly emarginate (*Westw.*). Long, 6¼ mill.

Reported from India.

11. BRACHYPLATYS BISTRIGA, Walker.

Brachyplatys bistriga, Walker, Cat. Het. i, p. 100 (1867).

Aeneous, finely punctured: head about two-thirds of the breadth of the thorax: antennæ, legs, marginal line on pronotum on each side which does not extend to the posterior angle, a very short line connecting the marginal line with the posterior angle, border of scutellum, marginal transverse lanceolate streaks on venter, each containing a black point, and the corium, pale luteous: costa of hemelytra black: wings blackish cinereous (*Walker*). Long 5¼ mill.

Reported from Bangalore.

12. BRACHYPLATYS COGNATA, Walker.

Brachyplatys cognata, Walker, Cat. Het. i, p. 101 (1867).

Aeneous-black, minutely punctured: head about two-thirds of the breadth of the thorax: an irregular interrupted line near the fore border of the head, a twice interrupted line between the eyes and a dot with a small longitudinal line on each side in the middle, the legs, antennæ, a waved line on pronotum which diverges on each side from the anterior margin to the posterior angle, a marginal line on each side ending near the posterior angle, sides of scutellum and transverse streaks on each side of the venter, luteous: scutellum slightly excavated at the tip *(Walker)*. Long 4—5 mill.

Reported from Burma.

13. BRACHYPLATYS ADJUNCTA, Walker.

Brachyplatys adjuncta, Walker, Cat. Het. i. p. 101 (1867).

Aeneous, minutely punctured: head about two-thirds of the breadth of the thorax: a mark on the disc of the head between two transverse interrupted lines and the lines themselves, antennæ, legs, a transverse undulating line on the thorax which extends along the foreborder and diverges on each side to the posterior angle and two marginal lines which do not extend to the posterior angle, border of scutellum, border of venter which emits short streaks to the disc, luteous: scutellum excavated at the tip *(Walker)*. Body long, 4¼ mill.

Reported from Burma.

Genus COPTOSOMA, Laporte.

Coptosoma. subg. *Coptosoma*, Lap., Ess. Hém. p. 73 (1832):—*Coptosoma*, Dallas, List. Hom. i, p. 61 (1851); Walker, Cat. Het. i, p. 83 (1867); Stål, Hem. Afric. i, p. 1, 9 (1864); En. Hem. v, p. 4, 10 (1876). Includes *Globocoris*, Hahn, Wanz. Ins. ii. p. 40 (1834).

Body very broadly ovate, above moderately convex, beneath somewhat flat or very slightly convex: head usually small and perpendicularly, or somewhat so, deflexed, narrower than the pronotum; tylus not reflexed anteriorly, lying entirely in the same plane: eyes rather prominulous; ocelli nearer to the eyes than to each other: antennæ inserted at the eyes: lateral margins of thorax posteriorly sinuate, before the sinus, usually distinctly amplified and foliaceous: scutellum somewhat amplified hindwards: feet somewhat short.

14. COPTOSOMA DUODECIMPUNCTATA, Germar.

Thyreocoris duodecimpunctatus, Germar, Zeitsch. i (i) p. 30 (1839); Herr. Schäff. Wanz. Ins. v, p. 14, t. 150, f. 474 (1839).

Coptosoma duodecimpunctatum, Dallas, List Hom. i, p. 62 (1851).

Coptosoma duodecimpunctata, Walker, Cat. Het. i, p. 86 (1867): Stål, En. Hem. v, p. 10 (1876): Distant, A. M. N. H. (5 s.) iii, p. 44 (1879).

Body brassy-black: border of thorax and venter; eight spots on the thorax (four on anterior margin, one on each lateral margin, and one in each lateral one-third) and four spots on the scutellum, red *(Germar)*. The feet are cinnamon-colour, brown towards the base; the broad red border of the abdomen is bidentate on each segment and has large black spiracula: scutellum with a yellow line within the free black border. Long, 6 mill.

Reported from Tranquebar, Assam: the Indian Museum has specimens from Sikkim and Samaguting (Assam).

15. COPTOSOMA CRIBRARIA, Fabricius.

Cimex cribrarius, Fabr., Ent. Syst. Suppt. p. 531 (1798).

Tetyra cribraria, Fabr. Syst. Rhyng. p. 143 (1803): Schiödte in Kröyer's Nat. Tidsskr. iv, p. 305 (1842).

Thyreocoris cribraria. Burm. Handb. ii (i) p. 384 (1835): Germar, Zeitschr i, (i) p. 26 (1839); Herr. Schäff. Wanz. iv, p. 84, t. 134, f. 416 (1834) and v, p. 31 (1839).

Coptosoma cribrarium, Am. & Serv. Hist. Nat. Ins. Hém. p. 66, t. 2, f. 4, (1843); Dallas, List Hem. B. M. i, p. 67 (1851; Vollenhoven, Faune Ent. l'Arch. Indo-Néer. i, p. 50 (1863); Stål, Hem. Fabr. i, p. 6 (1868).

Coptosoma atomarium, pt. Vollen. l. c. i, p. 50 (1863) ♂.

Coptosoma cribraria, Walker, Cat. Het. B. M. i, p. 87 (1867); Stål, En. Hem. v, p. 12 (1876): Scott, A. M. N. H. (4 s.) xiv, p. 289 (1874); Distant, Trans. Ent. Soc. p. 414 (1883).

Body small, somewhat round: thorax and scutellum flavescent, with very numerous impressed fuscous spots: scutellum somewhat emarginate at the tip: abdomen dull black in the middle; feet yellow (*Fabr.*). Long 3½—5 mill.

Vollenhoven's *C. atomarium* (nec Germar) is the ♂ of *C. cribraria* and is of a greyish or greenish-yellow, irregularly covered with deep black punctures on the posterior portion of the pronotum and on the scutellum: the head is small with an extremely fine edging of black on the anterior margin, a crescent-shaped black line on the vertex extending from one eye to the other: antennæ yellow, with the tip of the last joint brownish: eyes red: pronotum divided into two unequal parts by a row of excavated brown points, in front of this row there is sometimes a waved brown line; the posterior is punctured black: basal elevation on scutellum not tumid, excavated points larger but more distant than those on the thorax; beneath, head and pronotum yellow: meso- and meta-thorax slaty-grey; abdomen shining black with a broad yellow margin in which are the finely black-irised stigmata: feet yellow, last joint of tarsi, brown. Vollenhoven makes *C. cribraria* differ from his *C. atomarium* in its usually greater size, colour egg-yellow or greenish-yellow: punctuation blacker and smaller, the row of points on the pronotum is not so straight; scutellum throughout with a submarginal black line except on the basal elevation: abdomen yellow, with a large black patch in the middle from which proceed black rays running along the anterior margins of the segments and between these rays are small transverse black lines (*Voll.).* Long 3½—4 mill. ♂; 4—4½ mill. ♀.

Reported from Japan, Cochin-China, Burma, India, Ceylon, Timor, Sumatra; the Indian Museum has examples from Java, Calcutta, Sibságar and Dikrang valley (Assam). The Sumatran specimens have the yellow inclined to orange, those from Bengal are paler.

16. COPTOSOMA PARDALINA, Stål.

En. Hem. v, p. 13 (1876).

Yellow: pronotum behind the middle and on the impressions, finely punctured, the scutellum rather more strongly punctured, the punctures on the scutellum confluent in subreticulate and irregularly confluent masses and small lines, posteriorly less numerous, finer on the basal half: head semicircularly rounded before the eyes, margin narrow tylus and two triangular spots black: pronotum with the two typical, black transverse lines before the middle: pectus and venter black; ventral limbus and double row of lateral spots on each segment, flavescent; the anterior spot large, subtransverse, posterior spot small, sometimes very minute. Easily distinguished from *C. cribraria* by the head anteriorly more gradually rounded, dorsal punctuation stronger, marking blacker and more extended and the absence of lateral spots produced in long rays on the venter. Very like *C. lynceæ*, Stål, from Australia, differs in the punctuation and the black dorsal marking also in the sparingly punctulate base of scutellum and the ventral marking (*Stål*) Long, 4½; breadth of pronotum, 3½ mill.

Reported from India.

17. COPTOSOMA NEPALENSIS, Westwood.

Coptosoma nepalensis, Westwood, Hope Cat. Hem. i, p. 17 (1837): Stål. En. Hem. v, p. 13 (1876).

Thyreocoris nepalensis, Germar, Zeitschr, i, (i), p. 28 (1839).

Thyreocoris circumscriptus, Germar, l. c. p. 29 (1839).

Coptosoma nepalense, Dallas, List. Hem. i, p. 63 (1851).

Coptosoma circumscriptum, Dallas, l. c. p. 63 (1851): Walker, Cat. Het. i, p. 86 (1867).

Coptosoma cinctum, Vollenhoven, Faune Ent. l'Arch. Indo-Néer. i, p. 46 (1863).

Brassy black, very shining, punctured: head small, with two whitish cuneate spots before the eyes: pronotum with a very slender lateral and anterior border (interrupted in the middle), and a sublateral, angulated line, whitish; two small basal dots and a slender border on the scutellum, whitish; antennæ pale fuscous: feet whitish; femora fuscescent at the base; abdomen æneous; margin and sublateral spots, whitish *(Westw.)*. Body long, 4 mill.

Reported from Nepál. The Indian Museum has specimens from Sikkim.

18. COPTOSOMA CINCTA, Esch.

Scutellera cincta, Esch. Dorpat Abh. i, p. 161 (1822); Entomographia, p. 105 (1822).

Thyreocoris seminulum, Burm. Nov. Ac. Ac. Leop. xvi, Sup. i, p. 290 (1834).

Thyreocoris variegatus, Herr. Schäff. Wanz. Ins. iv, p. 83, t. 134, f. 414 (1839).

Thyreocoris cinctus, Germar, Zeitschr. i, (i), p. 27 (1839).

Coptosoma cinctum, Dallas, List Hem. i, p. 64 (1851); Walker, Cat. Het. i, p. 89 (1867); Stål, Ofvers. K. V.-A. Förh. p. 613 (1870).

Coptosoma cincta, Stål, En. Hem. v, p. 13 (1876).

Head somewhat longer than broad, forming anteriorly a stout angle, yellow; a median line, dark brown: eyes large, yellow: antennæ as long as the thorax, yellow, second joint shortest: thorax twice as broad as long, strongly excised anteriorly and much narrower than behind, sides weakly excised, surface convex, thickly punctured, black-brown: entire side-border yellow (with a brown longitudinal line on the anterior half), sides of fore-borders, a transverse line interrupted in the middle on the anterior half, and another irregular line in the middle towards the posterior margin: scutellum broad as long, posteriorly entirely obtuse, anteriorly convex, sloped posteriorly, grossly punctured, black-brown; the broad fore-border and the narrow outer margin smooth, yellow; with yellow dots in the middle: hemelytra yellow at the base: beneath and pectus pale grey: abdomen black, shining, punctured, the margin of each segment with a stout three-cornered yellow spot: feet yellow *(Esch.)*. Long, 2½—3; broad, 2—2½ mill.

Reported from Philippines. Specimens most probably representing this species come from Assam and Ceylon. Differs from *C. nepalensis*, Westw. in its smaller size and proportionately larger and more numerous yellow marks above.

19. COPTOSOMA SPHÆRULA, Germar.

Thyreocoris sphærula, Germar, Zeitschr.; (i) p. 25 (1839); Herr. Schäff. Wanz v, p. 15 and 30, t. 150, f. 476 (1839).

Coptosoma sphærulum, Dallas, List Hem. i, p. 64 (1851).

Coptosoma sphærula, Vollenhoven, Faune, Ent. l'Arch. Indo-Néer. p. 47 (1863); Walker, Cat. Het. i, p. 86 (1867); Stål, En. Hem. v, p. 14 (1873).

Bronzed black, shining, finely punctured: head without a spot; antennæ brownish-yellow: pronotum with a fine double border, yellow, extending from the anterior almost up to the posterior angles: scutellum bordered with yellow, except at its base: homelytra brown with a broad yellow border. Beneath, head black, pectus dull black with a transparent yellow border at the anterior angles: abdomen shining bronzed black, with a slight edging and with small sub-costal lines, yellow: feet yellowish-brown, deeper towards the coxæ (*Voll.)*. Long, 2—3 mills.

Reported from Java, China, Ceylon, N. Bengal.

20. COPTOSOMA PARVULA, Dallas.

Coptosoma parvulum, Dallas, List Hem. i, p. 65 (1851): Walker, Cat. Het. i, p. 87 (1867).

Coptosoma parvula, Stål, En. Hem. v, p. 15 (1876).

♂, ♀. Black, shining, convex, broader behind, very finely and densely punctured: head with a small reddish spot on each side before the eyes; the tylus reaching the anterior margin: eyes reddish brown: thorax with a faint transverse furrow across the middle; the anterior portion of the lateral margins yellow: scutellum wider behind, with a distinct transverse impressed line, near the base: homelytra margined with yellow at the base: body beneath black: abdomen with the outer margin and a submarginal spot on each side of each segment, orange: legs pale brownish orange, with the base of the femora brown: antennæ pale brownish orange, with the apical joint darker. (*Dallas.*) Long, 2½—3 mill.

Reported from India.

21. COPTOSOMA CICATRICOSA, Dallas.

Coptosoma cicatricosum, Dallas, List Hem. i, p. 66 (1851); Walker, Cat. Het. i, p. 87 (1867).

Coptosoma cicatricosa, Stål, En. Hem. v, p. 15 (1876).

♂. Body and abdomen black, shining, punctured: head rugose, eyes red: the lateral margins of the thorax much dilated, distinctly emarginate in front of the lateral angles; a strong transverse punctured furrow across the disc before the middle: scutellum with a strong transverse furrow at the base, the included space not elevated; the whole surface covered with smooth reddish, elevated spots, with the interstices thickly punctured: pectus grey, obscure: legs black: rostrum pitchy red with the apex black: antennæ black (*Dallas*). Long, 6¼ mill.

Reported from N. India.

22. COPTOSOMA XANTHOCHLORA, Walker.

Coptosoma xanthochlora, Walker, Cat. Het. i, p. 87 (1867).

Luteous, thinly and largely punctured, a little longer than broad; head about one-third of the breadth of the pronotum, with an abbreviated transverse black line on the hind border and with two short piceous longitudinal lines in front: pronotum with a large green patch on each side of the posterior margin: scutellum green, except the fore-part where there is a distinct abbreviated transverse furrow: pectus with a black disc: abdomen beneath, with black points on each side (*Walker*). Body long, 4½—5½ mill.

Reported from India.

23. COPTOSOMA INTEGRA, Walker.

Coptosoma integra, Walker, Cat. Het. i, p. 88 (1867).

Æneous-black, largely punctured: head a little more than one-third of the breadth of the pronotum, luteous along each side in front: pronotum with a luteous transverse line which extends along the anterior border and is dilated on each side where it includes a slender black streak: scutellum with the border luteous, not excavated at the tip, with a transverse furrow in front: abdomen beneath, luteous on each side: legs luteous (*Walker*). Body long, 2½—3 mill.

Reported from India.

24. COPTOSOMA BREVIS, Walker.

Coptosoma brevis, Walker, Cat. Het. i, p. 89 (1867).

Black, very minutely punctured, not longer than broad: head one-third of the breadth of the thorax with a broad curved yellow stripe on each side in front: eyes red: antennæ tawny: pronotum with two yellow lateral stripes which are interlined with black; the forepart with two narrow, yellow, slightly interrupted and undulating bands: scutellum bordered with yellow, except in front, where there is a yellow band: abdomen beneath, yellow on each side; legs yellow. Differs from *C. sphærulæ*, Germ. in the continuous band at the base of the scutellum and from *C. hilaris*, Walker, by the speckled scutellum (*Walker*). Body long, 3—3¼ mill.

Reported from Burma.

The following species of this sub-family may be noted as likely to occur in India.

Tarichea chinensis, Dallas, List Hom. i, p. 74 (1851). China.
Calacta lugubris, Stål, A. S. E. F. (4 s.) v, p. 163 (1865). Hongkong.
Coptosoma tigrina, Stål, En. Hem. v, p. 13 (1876). Cochin-China.
Coptosoma punctiventris, Stål, l. c., p. 13. Malacca.

25. COPTOSOMA ASSAMENSIS, Atkinson.

Proc. A. S. B. p. 174 (1886).

Bronzed-black, shining, very closely and finely punctured: juga yellow, with a very fine blackish external limbus: eyes large, prominulous, deep castaneous: lateral margins of pronotum (enclosing anteriorly a black longitudinal streak) broadly forward, narrowly hindward, also four oblong transverse spots (2 and 2) on anterior part, the pair nearest anterior margin smaller, and a broadly oval spot at each posterior basal angle, yellow: the third basal part of scutellum, black arcuate hindward, with two yellow, oblong, transverse elongate spots before the basal impression: sides very broadly and apical two-thirds rather sordid yellow, thickly and coarsely punctured fuscous, with a large rounded black spot in the middle of each posterior angle: abdomen beneath shining black; feet sordid flavescent. Long, $2\frac{1}{2}$—3; broad, $2\frac{1}{2}$ mill.

Reported from N. E. Assam.

Subfam. CYDNINA, Stål.

En. Hem. v, p. 17 (1876):—*Cydnida*, Stål, Hem. Afric. i, p. 18 (1864): *Cydnini*, Schiödte, Nat. Tidsskr. p. 454 (1849): *Cydnidæ*, Dallas, List Hem. i, p. 109 (1851); Walker, Cat. Het. i, p. 147 (1867): *Cydnides*, Signoret, A. S. E. F. (6 s.) i, p. 25 (1881).

Antennæ remote from the lateral margins of the head, inserted near the base of the head, or not more remote therefrom than the anterior margin of the eyes, 4-5 jointed: rostrum 4-jointed, rising near the labrum and apex of the head: scutellum variable, moderate or very large: costal margin of corium prominulous beyond the lateral margins of the body throughout its entire length, or at least for half its length: first ventral segment, or at least the sides, covered by the metastethium, the extreme posterior margin only visible: lateral margins of venter completely entire, not incised between the segments, the angles of the segments not prominulous: tibiæ spinose: propleura convex, posteriorly depressed (*Stål*).

Sec. I CYDNIDES, Signoret.

A. S. E. F. (6 s.) i, p. 25 (1881); iii, p. 521 (1883): *Cydnida*, Stål, Hem. Afric. i, p. 11 (1864).

Having piliferous points on the vertex and the pronotum both in front near the anterior margin and also on the disc near the transverse impression and above. These piliferous points exist almost in the same places in all species—four on the disc of the head, of which two are situate above the eyes, one on each side, and two towards the tip of the lateral lobes (*juga*); six on the pronotum of which four are situate on the anterior margin, and two lateral on the disc near the transverse impression. Where the pile or hairs are wanting, their existence is indicated by points or dots which do not occur amongst the second section comprising the *Sehirides.* The generic characters of the *Cydnides* are chiefly drawn from the piliferous points or dots other than those mentioned which are especially found along the lateral margins of the head, the pronotum or the hemelytra.

Genus CEPHALOCTEUS, Leon Dufour.

A. S. E. F. (1 s.) iii, p. 342 (1834) ; Am. & Serv. Hist. Nat. Ins. Hém., p. 94 (1843) ; Fieber. Eur. Hem. p. 83, 362 (1861) ; Walker, Cat. Het. i, p. 163 (1867) ; Stål, En. Hem. v, p. 21 (1876) ; Signoret, A. S. E. F. (6 s.) i, p. 38 (1881) :—*Cephaloctenus,* Schiödte, Kroyer's Tidsskr. iv, p. 330 (1843) ; (2 s.) ii, p. 449 (1849).

Eyes hardly visible, composed only of a small tubercle surmounted by one or two others ; ocelli absent : head longer than broad, spinulose, ciliated on the margin and the vertex ; the juga are longer than the tylus which is, however, free in front : antennæ 5-jointed, the first joint is the longest, the two last shortest, globose : rostrum reaching the intermediate pair of feet : the second joint stoutest and longest : pronotum twice as broad as long, very pilose on the sides and on part of the disc : scutellum longer than broad, acuminate : hemelytra shorter than the abdomen, membrane very short, veinless, also the corium which is bordered with numerous hairs and has some on the disc : wings rudimentary : feet short and stout ; femora amplified ; the intermediate and last tibiæ much ciliated over their whole surface ; the first pair with ten spines on the outer side, apparently mobile, and increasing in length and breadth from base to tip, the internal side furnished with four spines having very long hairs ; tarsi long and slender ; claws with appendages in the form of bristles : abdomen with numerous hairs on the disc and on the sides, the ostiolar canal more or less confused in the mesosternal groove with the ostiole towards the middle and forming an oblique opening with a distinct margin at the base and almost none at the tip *(Sign.)*.

26. CEPHALOCTEUS MELOLONTHOIDES, Schiödte.

Cephaloctenus melolonthoides, Schiödte, in Kröyer's Nat. Tidsskr. iv, p. 332 (1843).

Cephalocteus melolonthoides, Stål, En. Hem. v, p. 21 (1876) : Sign. A. S. E. F. (6 s.) i, p. 40 (1881).

Fuscous or piceous, with ferruginous hairs ; scutellum and hemelytra at the apex of a weaker colour, membrane albescent at the apex : antennæ and rostrum ferruginous : neck pale yellow : feet rufous ; posterior tibiæ piceous, spines fuscous ; all the tarsi pale. Head occupying almost one-sixth of the length of the body, broader than long by one half, somewhat convex, impressed towards the sides with some unequal punctures ; anterior margin of the head between the somewhat exserted eyes broadly rounded, deeply incised in the middle : sides of clypeus converging towards the apex, united by a small transverse furrow behind the middle : pronotum at least twice as broad as its median length, scarcely twice as long as the head, narrower than the basal breadth by one-third at apex, convex, the convexity transverse, almost the third part of a circle ; disc often flatly impressed in the middle, convexly sloped anteriorly and at the sides ; densely and minutely punctured, somewhat smooth towards the anterior angles : scutellum almost twice as long as the pronotum, longer by a fourth than the basal breadth, somewhat convex, densely punctured ; anterior angles very acute ; lateral margins, straight, apex broadly rounded : hemelytra as broad as half of the anterior margin of the scutellum, densely punctured, somewhat convex, sides convexly sloped, externally rounded : venter somewhat smoothish, with ferruginous hairs (*Schiödte*). Long, 3¾ mill.

Reported from Travancore.

Genus STIBAROPUS, Dallas.

List Hom. i, p. 111, 125 (1851) : Walker Cat. Het. i, p. 166 (1867) : Stål, En. Hem. v, p. 13 (1876) : Sign. A. S. E. F. (6 s.) i, p. 43 (1881). Includes *Pachycnemis*, Jakowleff, Hém. Cauc., Trudy Russ. Ent. Obch. viii, p. 54 (1875).

Head very little longer than broad, rounded in front, with the apex very slightly emarginate ; the margins closely set with spines, the juga meeting beyond the tylus; eyes of moderate size, globose, prominent : ocelli very large, distant, placed close to the anterior margin of the pronotum : antennæ short, not twice the length of the head, five-jointed, gradually increasing in thickness from the base to the apex ; basal joint short, second very small, third longest, gradually thickened towards the apex, fourth and fifth ovate : rostrum slender, reaching the posterior coxæ, inserted close to the apex of the head ; basal and third joints about equal, second and fourth also about equal, longer than the others, fourth thinnest : body oblong-ovate : thorax a little broader than long, almost semicircular in front : scutellum rather longer than broad, with the apex broad. Membrane well developed, passing beyond the apex of the abdomen, with longitudinal veins : anterior tibiæ compressed, cheliform, slightly curved, with the basal half of the outer margin spinose, the inner margin fringed with hairs, especially at the apex ; tarsi inserted at about one-third of the length of the tibiæ from the apex, very long and slender, three-jointed; basal joint very long, forming more than half the tarsus, second shortest, third about half as long as the first; intermediate tibiæ somewhat clavate, strongly curved, thickly set with spines on the outside, especially towards the apex; tarsi inserted at the apex of the tibiæ, rather short, three-jointed, apical joint longest, second shortest; posterior legs very stout, rather short; femora very broad, somewhat compressed; tibiæ very short, sparingly spinous on the outside, much enlarged and abruptly truncated at the extremity, forming a large oval disc, surrounded by closely set spines; these spines at the extremity of the inner margin run in a single oblique line across the inner surface of the tibiæ, towards the upper margin and in the angle formed by this row of spines with the truncated posterior margin, the tarsi are inserted, and lie so concealed by the ring of spines surrounding this margin as to elude detection except upon a very close examination; the tarsi are short, three-jointed, the apical joint largest, the basal joint very little longer than the second (*Dallas*).

27. STIBAROPUS LATIPES, Westwood.

Cydnus latipes, Westwood, Hope, Cat. Hem. i, p. 18 (1837): Stål, En. Hem. v, p. 26 (1876).

Stibaropus brunneus, Dallas, List Hem. i, p. 125, t. 3, f. 1 (1851); Walker, Cat. Het. i, p. 166 (1867); Stål, En. Hem. v, p. 17 (1876).

Stibaropus latipes, Signoret, A. S. E. F. (6 s.) i, p. 44, t. 1, f. 4 (1881).

♀. Head, thorax and scutellum pitchy castaneous, more or less transversely rugose: head castaneous in front with the vertex pitchy: ocelli red: thorax with a shallow furrow across about the middle, in front of which is a distinct, transverse, elevated line; the portion of the thorax behind the furrow is finely transversely rugose as also the scutellum which is furnished with a few scattered punctures. Corium and clavus castaneous-brown, finely and densely punctured; membrane pale brownish-yellow, semitransparent: body beneath pale castaneous, impunctate; abdomen clothed with short hairs and with the apex pitchy: legs pale castaneous, with the posterior tibiæ, darker; anterior tibiæ with the apex black; tarsi reddish: rostrum and antennæ reddish testaceous; antennæ darker (*S. brunneus*, Dallas., Long, 10½ mill.

Reported from N. India.

28. STIBAROPUS MOLGINUS, Schiödte.

Scaptocoris molginus, Schiödte, Kröyer's Nat. Tidsskr (2 s.) ii, p. 458 (1849).
Stibaropus molginus, Stål, En. Hem. v, p, 17 (1876): Sign. A. S. E. F. (6 s.) i, p. 45 (1881).

Suboval: rostrum as long as the pectus: second joint of the antennæ longer by half than the third: scutellum transversely rugose, broadly rounded at the apex: hemelytra punctured, piceous-castaneous; vertex and anterior part of pronotum, black piceous: clavus and exterior margin of corium on the hemelytra, castaneous-rufous: beneath with feet castaneous: pleura piceous; first pair of tibiæ black at the apex. Head very densely rugulose: last joint of the antennæ oblong-oval, as large as the third: second joint of the rostrum a little thickened, distinctly curved: anterior part of the pronotum minutely reticulose, the reticulation unequal, posterior part transversely rugulose, the wrinklets equal, very dense, punctulate: scutellum as long as the pronotum, rugulose like the posterior part of the pronotum, exceeding by one-sixth the basal breadth; a little dilated at the extreme tip, broadly rounded, almost truncated, margin broadly depressed: hemelytra distinctly punctured; exterior area of corium divided into two parts by a straight stria; marginal part narrow, punctulate, the anterior part broad, very smooth: membrane flavescent (*Schiödte*). Long, 9½—10½ mill.

Reported from Rangpur (Bengal): a single specimen from Jalpaigori.

29. Stibaropus tabulatus, Schiödte.

Scaptocoris tabulatus, Schiödte, Kröyer's Nat. Tidsskr. (2 s.) ii, p. 459 (1849).

Stibaropus tabulatus, Stål, En. Hem. v, p. 17 (1876): Sign. A. S. E. F. (6 s.) i, p. 45 (1881).

Briefly obovate: rostrum as long as the pectus: second joint of antennæ one-fourth longer than the third: scutellum transversely striated, acutely rounded at the apex: hemelytra smooth. Weakly fulvous-castaneous; a double somewhat ring-shaped patch on the anterior part of the pronotum and the humeral protuberances, piceous: first pair of tibiæ fuscous at the apex; a transversely linear black spot near the posterior margin of the fifth ventral segment, somewhat triangularly dilated forwards in the middle of the segment: last ventral segment in ♂, piceous. Head strongly rugose: last joint of the antennæ elongate. Sovate, one fourth longer than the third: second joint of rostrum curved as regards the form of the anterior setæ: pronotum more distinctly constricted than in *S. molginus* and more narrowed towards the apex, anterior part more deeply reticulose, posterior part transversely striated, the striæ robust, here and there confluent: scutellum scarcely longer than the pronotum, exceeding by one sixth the basal breadth, transversely striated, the striæ rather regular, deep, gradually more distant towards the apex; apex scarcely dilated, acutely rounded, margin narrowly depressed: hemelytra smooth or very obsoletely punctured, exterior area of corium divided by an inwardly arched stria; marginal part broad, interior part narrow, linear, dilated towards the apex: membrane flavescent (*Schiödte*). Long, 7 mill.

Reported from Travancore.

30. STIBAROPUS CALLIDUS, Schiödte.

Scaptocoris callidus, Schiödte, Nat. Tidsskr. (1 s.) ii, p. 460 (1849).

Stibaropus callidus, Stål, En. Hem. v, p. 17 (1876): Sign. A. S. E. F. (6 s.) i, p. 46 (1881).

Obovate: rostrum as long as the prosternum: second joint of the antennæ as long as the third: scutellum somewhat convex, rugosely punctured, rounded at the apex: hemelytra minutely punctured. Ferruginous-castaneous, anterior part of the pronotum and base of the scutellum and hemelytra more obscure: apices of femora usually piceous, first pair of tibiæ fuscous at the apex: last ventral segment in ♂ with a blackish spot. Head densely punctured, punctuation rugose: last joint of antennæ oval, one-fourth longer than the third: second joint of rostrum straight, third roundly dilated above: anterior part of pronotum very minutely reticulose, the reticulation unequal, disc usually somewhat smooth, posterior part deeply and densely punctured, the punctures transverse, here and there confluent: scutellum one-fourth longer than the pronotum, longer by half than the basal breadth, punctures transverse, very dense at the base, here and there confluent, more distant towards the apex and gradually decreasing in size; apex scarcely dilated, obsoletely margined, broadly rounded: the hemelytra minutely punctured; exterior area of corium without a dividing line; with a longitudinal impression at the base, deeply punctured, remotely and very minutely punctured towards the apex: membrane whitish (*Schiödte*). Long, 5—5½ mill

Reported from Serampur (Bengal). Found flying in the evening on the banks of the Hughli river.

31. STIBAROPUS FLAVIDUS, Signoret.

Stibaropus flavidus, Sign., A. S. E. F. (6 s.) i, p. 47, t. 2, f. 6 (1881).

Yellow, rugose: head semi-horizontal, semi-perpendicular, the tylus shorter than the juga, with two bristles at the tip, the juga with six: eyes very prominent; ocelli almost pedunculate or at least borne on a small tubercle: rostrum reaching the insertion of the intermediate feet, the first joint very long: the second joint of the antennæ very short, the third thrice as long as the second, the first almost as long as the third: pronotum rugose, twice as broad behind as in front, the anterior border marginate; a transverse groove beyond the middle; lateral margins pubescent: scutellum longer than broad, rugose, almost carinate in the middle, broadly rounded at the tip: hemelytra long, finely punctured; membrane broad, white, with five veins: feet robust, pubescent, spinose, the anterior small; tibiæ curved, concave beneath, having the tarsi inserted before the tip; the posterior very stout, the tibiæ ending in a robust, spinose stump : abdomen pubescent; ostiolar canal much grooved, reaching three-fourths of the metasternum and ending in a rounded lobe with the odoriferous aperture invisible. Allied to *S. callidus.* Schiödte, differs in having the second joint of the antennæ shorter than the third, and the rostrum being longer (*Sign.*). Long, 6; broad, 2¾ mill.

Reported from N. India.

32. STIBAROPUS (?) MINOR, Walker.

Stibaropus minor, Cat. Het. i, p. 166 (1867).

Piceous, elliptical, convex, shining; head slightly rugulose, about one-third of the breadth of the thorax: rostrum, antennæ and legs ferruginous: thorax minutely punctured in front of the antemedial transverse furrow; hind part transversely rugulose: scutellum minutely rugulose, with a transverse impression very near the tip: legs incrassated; tibiæ clavate, setose; tarsi slender: hemelytra minutely punctured; membrane pale cinereous (*Walker*). Long, 5¼ mill.

Reported from Burma.

33. STIBAROPUS (?) TESTACEUS, Walker.

Stibaropus testaceus, Walker, Cat. Het. i, p. 166 (1867).

Testaceous, oval, thick, convex, shining: head somewhat conical, slightly rugulose, about one-third of the breadth of the thorax which is thickly and minutely punctured, with a transverse median furrow: scutellum transversely and minutely rugulose: legs short; tibiæ setose; anterior femora and tibiæ thick; hind femora and tibiæ much incrassated: hemelytra very minutely punctured; membrane pale cinereous (*Walker*). Long, 5¼ mill.

Reported from India.

Genus LACTISTES, Schiödte.

Kröyer's Nat. Tidsskr. (2 s.) ii, p. 456 (1849); Stål, En. Hem. v, p. 17 (1876), Sign. A. S. E. F. (5 s.) ix, p. clxxii (1879); l. c. (6 s.) i, p. 48 (1881).

In this genus, as in the preceding, the anterior tarsi appear to be inserted before the end of the tibiæ, due to a prolongation of the end of the tibia (which is itself more or less emarginate) arising from the union of the apical spines. Head normally ciliated : juga inclosing the tylus: vertex more or less rugulose; eyes spinose at the base: pronotum much narrower in front, with a median transverse impression: corium almost twice as long as the membrane, the latter extending slightly beyond the abdomen: ostiolar canal more or less rugose, with the *ostiole* in an emargination beneath and usually accompanied by a small hook-shaped tongue (*Sign.*). In *Stibaropus*, the posterior tibiæ are thickened; in *Lactistes*, they are slender; in *Scoparipes*, they have a longitudinal row of brush-shaped hairs, and in *Adrisa*, they are cylindrical. Schiödte separates *Cephalocteus* and *Lactistes* thus :—

Cephalocteus.	*Lactistes.*
Tarsi equal, very minute. Posterior tibiæ clavate, setose, externally very spiny. First tibiæ pectinate, truncate.	Tarsi unequal, first pair longer, last tibiæ narrow, compressed, spiny. First tibiæ pectinate, hamate.

34. LACTISTES RASTELLUS, Schiödte.

Lactistes rastellus, Schiödte, Kröyer's Nat. Tidsskr. (2 s.) ii, p. 457 (1849): Stål, Ovors. K. V.-A. Förh. p. 614 (1870); En. Hem. v, p. 17 (1876): Sign. A. S. E. F. (6 s.) i, p. 49, t. 2, f. 8 (1881).

Blackish-brown, shining, oval: first pair of tibiæ rounded internally before the apex: third joint of antennæ one-fourth shorter than the second which is cylindrical. One-half longer than its greatest breadth before the base of the pronotum; somewhat convex, shining, castaneous, the antennæ and feet of a weaker colour. Head shorter by one-third than its greatest breadth through the eyes, rugosely punctured, flattish, margin somewhat elevated, minutely incised in the middle, frontal striæ converging from the median length: rostrum reaching the intermediate coxæ, second joint straight above: antennæ exceeding the head by one-fifth, first and second joints of the same length, cylindrical, the second twice as slender, third obconical, last two equal, ovate, one-fourth longer than the third: pronotum one-sixth longer than the anterior breadth, shorter by half than the basal breadth, convex, somewhat flatly sloped towards the apex, distinctly constricted behind the middle, densely punctured, posterior margin and anterior protuberances very smooth; sides sinuated behind the middle; anterior angles obtuse, posterior angle somewhat straight, callous, prominulous beyond the margin of the hemelytra: scutellum as long as the pronotum, scarcely exceeding the basal breadth, rather densely punctured, apex somewhat deflexed, somewhat obtuse: hemelytra densely punctured, membrane hyaline (*Schiödte*). Long, 5¼ mill.

Reported from Serampur (Bengal), Philippines.

35. LACTISTES VICINUS, Signoret.

Lactistes vicinus, Sign., A. S. E. F. (6 s.) i, p. 50 t. 2, f. 9 (1881).

♀. Close to *L. rastellus*, Schiödte, but differs from it in the much shorter, broad, and rounded tip of the tibiæ, in the internal edge of the tibiæ being without tubercles, whilst the external edge has 5-6 robust spines or teeth. Head rounded, emarginate in front, juga united with the tylus, borders with a rim ; less rugose : pronotum punctured, margins ciliated : hemelytra with three piliferous points : abdomen punctured : the ostiolar canal more sinuous in front and behind, ending in a lobe more angularly rounded, with a small tooth at the emargination : smooth part of the mesosternum punctured : third joint of antennæ oval, as long as the second but stout ; 4-5 joints are equal and longest (*Sign.*). Long, 7¼ ; broad, 3⅓ mill.

Reported from N. India.

36. LACTISTES TRUNCATO-SERRATUS, Signoret.

Lactistes truncato-serratus, Sign., A. S. E. F. (6 s.) i, p. 51, t. 2, f. 10 (1881).

♀. In colour and form like *L. vicinus*, Sign., but differs especially in the dilated prolongation of the posterior tibiæ which is short and presents at the last spine of the external side two emarginations that form three rounded teeth: the tarsi are very long. Head rounded, emarginate in front, the tylus shorter than the juga but free, the juga not touching at the tip : pronotum more punctured, with two irregular smooth spaces on the anterior disc : scutellum less densely punctured : hemelytra without piliferous points : abdomen punctured on the sides, on the mesosternum in the glossy lateral part, and on part of the metasternum and near the insertion of the posterior femora : the episternum much punctured : the ostiolar canal very irregular, ending in a small lobe, rounded, with a valveless emargination, not a tooth (*Sign.*). Long, 7½ ; broad, 3½ mill.

Reported from N. India.

Genus SCOPARIPES, Signoret.

B. S. E. F. (5 s.) ix, p. clxxii (1879) ; l. c. p. 235 (1879) : l. c. (6 s.) i, p. 202 (1881).

Distinguished by the form of the posterior tibiæ in the ♂ which are long, flattened, more narrow at the base and at the tip and have on the internal surface a line or edge furnished with short, stiff hairs very close, and the same line but with a few hairs only in the ♀ ; on the external surface, there are spines as in the other genera of this section. Head more or less rounded and furnished on the margin with hairs and rather stout spinules ; antennæ 5-jointed of which the third is shorter than the second : ostiolar canal broad, grooved transversely and ending in a broad lobe with the lower opening surrounded by a kind of hood (*Sign.*).

37. SCOPARIPES LONGIROSTRIS, Signoret.

Scoparipes ? longirostris, Sign., A. S. E. F. (6 s.) i, p. 205, t. 7, f. 24 (1881).

Brown-black; somewhat parallel, elongate: rostrum and tarsi, yellowish: two first joints of the antennæ, black, the rest brownish. Head rounded in front, striated, finely punctured, spinulose, and ciliated on the margin: second joint of the antennæ longer than the third: rostrum very long, reaching the second ventral segment, the joints almost equal, the second joint much arched: pronotum almost square, anterior angles rounded, anterior border much emarginate, and strongly impressed, finely punctured, also the lateral margins and on the median transverse line; much ciliated on the borders: scutellum rounded, impressed at the tip and very concave; disc punctured: hemelytra shorter and narrower than the abdomen, finely punctured, with 7-8 piliferous points on the external side; membrane brown: feet black: anterior tibiæ, broad, with the usual spines: abdomen glossy in the middle, punctured and striated on the sides (*Sign.)*. Long, 12; broad, 6 mill.

Reported from India ?

Genus ADRISA, Am. & Serv.

Hist. Nat. Ins. Hém. p. 89 (1843): Stål, En. Hem. v, p. 20 (1876): Signoret. A. S. E. F. (6 s.) i, p. 205 (1881). Includes *Acatalectus*, Dallas, List Hem. i, p. 110, 122 (1851); Walker, Cat. Het. i, p. 64 (1867) and *Geobia*, Montr. Ann, Soc. Linn. Lyon. (2 s.) v, p. 245 (1858).

Distinguished by its 4-jointed antennæ, due to the union of the second and third joints; first joint short, not extending beyond the anterior margin of the head, second scarcely or as long as the third and fourth together, second joint gradually thickened from base to tip and a little pubescent, third and fourth almost of equal length and very pubescent: second joint of rostrum thickest and longest, the fourth is shortest, almost as long as the first; body oval, a little convex; corium twice as large as the membrane: scutellum angular at the tip: the meso-and meta-sternal *plaques mates* very large, the upper reaching the lateral margin above the mesosternal furrow: the ostiolar canal which reaches the middle of the metasternal space is more or less waved and ends in a tubercle or rounded or angulated lobe; it is emarginate beneath with a lage valvule varying with the species: feet and abdomen normal (*Sign)*.

38. ADRISA MAGNA, Uhler.

Acatalectus magnus, Uhler, Proc. Ac. Nat. Sci. Phil. p. 222 (1860); Stål, En. Hem. v, p. 27 (1876).

Adrisa magna, Signoret, A. S. E. F. (6 s.) i, p. 206, t. 7, f. 25 (1881).

♀. Black, shining, much punctured, the punctuation more or less confluent, head rounded, emarginate, with the anterior margin narrowly recurved, juga meeting by a point of their surface in front of the tylus, coarsely and deeply rugosely punctured : eyes testaceous, ocelli reddish : antennæ piceous, pubescent, terminal joints paler; rostrum pitchy black, second joint thickened ; thorax subquadrate, anterior angles a little oblique and rounded, behind the head, a slightly elevated, irregularly crescent-formed surface, smooth and impunctate, remaining surface very deeply, coarsely and confluently punctured, a series of very fine punctures along the lateral margins, basal margin subtruncate, smooth, with a very few coarse punctures : scutellum shining, rugosely punctured, impunctate at the apex : corium subopaque, very finely and closely punctured ; membrane fuliginous, somewhat opaque, freckled with spots of yellow, beneath scabrescently punctured, venter densely so, its disc shining, impunctate, margins trenchant ; legs deep black, shining, anterior and middle femora ciliated beneath, with a row of long slender spines, those upon the posterior pairs very short, tibiæ densely spinose (*Uhler*). Long, 19 ; breadth of abdomen, 10½ mill.

Reported from Hong-Kong.

39. ADRISA (?) CLARA, Walker.

Acatalectus clarus, Walker, Cat. Het. iii, p. 535 (1868).

Black, elliptical, rather flat : sides of the head and of the thorax with a few bristles : head hardly punctured ; sides and fore border very slightly reflexed : eyes, rostrum, antennæ and legs, piceous : rostrum extending to the middle coxæ : 1-4 joints of the antennæ successively increasing in length : thorax sparingly and minutely punctured, smooth, except on each side in front of a transverse middle furrow ; a ferruginous patch on each hind angle : scutellum rather thinly punctured, smooth at the base, with a narrow ferruginous border on each side : legs stout ; femora slightly dentate beneath ; tibiæ spinose : hemelytra piceous, more thickly punctured than the thorax, with two veins near the costa and with four near the hind border ; membrane colourless. (*Walker*). Long, 10½ mill.

Reported from India.

Genus ÆTHUS, Dallas.

Pt., List Hem. i. p. 110 (1851) : Walker, Cat. Het, i, p. 148 (1867) : Stål, Hem. Afric. i, p. 19, 20 (1864) ; En. Hem. v, p. 18 (1876) : Sign. A. S. E. F. (6 s.) i, p. 423 (1881). Includes *Cydnus*, Fieber, Eur. Hem. p. 83, 363 (1861).

Body oval or ovate, slightly convex ; margins at least of the head, pilose or setose : head rounded at the apex, juga and tylus equally long ;

bucculæ continued through, slightly elevated : first joint of the rostrum not extending posteriorly beyond the bucculæ: antennæ 5-jointed, very often somewhat short and furnished with subfusiform apical joints; scutellum triangular, longer than broad, frena extended almost to the apex: corium longer than the scutellum, with the apical margin straight: prosternum longitudinally impressed: feet moderate, femora sparingly setose, tibiæ very spinose, first pair much compressed, upper margin spinosely pectinate *(Stål)*.

Signoret (l. c.) restricts *Æthus*, to those species of Dallas which have the head spinulose and ciliated and in which the ostiolar canal does not end in a cornet or ear-shaped opening of which the borders are more or less flattened.

40. ÆTHUS INDICUS, Westwood.

Cydnus indicus, Westwood, Hope, Cat. Hem. i, p. 19 (1837); Stål, En. Hem. v. p. 26 (1876); Sign. An. Mus. Gen. xvi, p. 632 (1880); Lethierry, l, c. xviii, p. 649 (1883).

Æthus perosus, Stål, Ofvers. K. V.-A. Förh. p. 214 (1853); Hem. Afric. i, p. 28 (1864); Ofvers. K. V.-A. p. 614 (1870); En. Hem. v, p. 18 (1876).

Æthus impressicollis, Signoret, A. S. E. F. (3 s.) viii, p. 923 (1861).

Æthus indicus, Dallas, List Hem. i, p. 114 (1851); Walker. Cat. Het. i, p. 155 (1867); Signoret, A. S. E. F. (6 s.) ii, p. 28, t. 1, f. 69 (1882).

Small, black, shining, ovate, punctured: antennæ moderate ; sides of body setose : feet moderate, black : anterior tibiæ, broad, spinose, four posterior setiferous (*Westwood)*. Body long 6 mill.

♂, ♀. Oval or ovate, black-piceous: head somewhat obtusely rounded, rarely somewhat semicircular, distinctly punctured, the base and the tylus smooth, margin slightly reflexed, remotely pilose: antennæ fuscous-piceous, apical joints of a weaker colour, somewhat short, three last joints somewhat incrassate, second a little shorter than the third : thorax convex, in ♂, impressed before the middle, rather densely and distinctly punctured, the base and transverse space before the middle, smooth, lateral margins remotely pilose: scutellum moderately densely punctured: hemelytra distinctly punctured ; membrane sordid hyaline or very slightly infuscate: sides of venter sparingly punctured: tarsi yellow piceeus (*Æ. porosus*, Stål). Long, 5½—6 ; broad, 3—3½ mill.

Reported from S. Africa, Madagascar, Flores, Celebes, Borneo, Java, China, Burma, India, Bombay.

41. ÆTHUS BORREI, Signoret.

Æthus borrei, Signoret, A. S. E. F. (6 s.) ii, p. 32, t. 2, f. 73 (1882).

♂. Brown, oval, shining, sparingly and strongly punctured: rostrum, antennæ coxæ and feet, yellow; tarsi of a lighter colour; spines on feet, black. Head rounded, emarginate in the middle, the tylus shorter than the juga, the latter inclosing it, the borders also defined and posteriorly with 13-14 piliferous points on each side: vertex almost smooth, obsoletely striated: three ocelli near the eyes: rostrum reaching the intermediate coxæ, antennæ short, the second joint shorter than the third: pronotum very convex, with a strong line of dots behind the emargination and a slight impression; others at the anterior angles and on the transverse impression; the lateral margins sinuate and with 13-14 ciliated points: scutellum with the tip angularly rounded, rugosely and sparingly punctured on the disc, the base smooth: hemelytra strongly punctured; the marginal side visible to the tip but indistinct from the middle of the corium, and appearing crenulated, due to the presence of nine piliferous points or dots: the internal radial vein ending in the middle of the corium: membrane very long, of a light yellow hyaline and extending from near its half beyond the abdomen; feet yellow, with black spines; anterior tibiæ very broad, with seven stout spines, the sixth and seventh almost united as in *Lactistes*: abdomen smooth, impressed on the sides, in the space occupied by the ciliated points and the stigmata: *plaques mates* striated and punctured, the upper ending in a point on the suture, the lower separated from the smooth lateral space by an almost straight line; the ostiolar canal not reaching the middle of the metasternum and ending in a reniform lobe, with a valvular tooth in the indentation. Differs from *Ae. indicus*, Westw. by its much broader head, almost smooth, and the tylus shorter than the juga which inclose it. In *Ae. indicus*, the head is longer than broad between the eyes and the tylus is very narrow in front and as long as the juga which almost inclose it (*Sign.*). Long, 7; broad, 4 mill.

Reported from Silhet.

42. ÆTHUS PERPUNCTATUS, Signoret.

Æthus ? perpunctatus, Sign., An. Mus. Gen. xvi, p. 634 (1881); A. S. E. F. (6 s.) ii, p. 34, t. 2, f. 75 (1882).

Black: broadly oval, convex, much punctured over its entire surface, much ciliated on the head and pronotum: two glossy spaces on the anterior disc of the pronotum, at the basal angles of the scutellum and a median line on the latter almost carinate. Head rounded in front; the tylus very narrow at the tip which reaches the juga, margins slightly reflexed: pronotum ciliated on the sides and on the surface near the margin at the anterior angles; hemelytra much ciliated on the marginal side, with 12-13 piliferous points: membrane short, brown: feet black; tarsi pale; anterior tibiæ with eight spines on the external side and four on the internal side: second joint of the antennæ much longer than the third: rostrum reaching the intermediate feet: ostiolar canal ending in the middle of the episternum, much rounded at the tip which is curved back beneath, with a valvular emargination: the episternums with three small dull plates *(plaques mates)*, that of the mesosternum occupying the entire internal angle along the coxa and continued on the suture up to the border; the lower, or that of the metasternum, occupying only the space above the extreme lobe of the ostiolar canal (*Sign.*) Easily distinguished by its abundant punctuation and the form of the ostiolar canal. Long, 6; broad, 3½ mill.

Reported from Khandalla (Bombay ?).

43. ÆTHUS MAURUS, Dallas.

Æthus maurus, Dallas, List Hom. i, p. 118 (1851); Walker, Cat. Het. i, p. 158 (1867); Stål, En. Hem. v, p. 26 (1876); Distant, Scien. Res. 2nd Yarkand Miss. p. 3 (1879).

♂, ♀. Black somewhat shining, very thickly and finely punctured: head as long as broad, with the anterior margin semicircular, very faintly notched at the tip, juga not passing the tylus: ocelli not very large, red: thorax with a faint punctured transverse furrow about the middle, the anterior and lateral margins, and the portion of the disc behind the transverse furrow, very thickly and finely punctured: scutellum rather elongated, very thickly and finely punctured. Coriaceous portion of the hemelytra pitchy castaneous, finely and rather thickly punctured, the punctures closer on the line of the veins, near which it is darker than on the rest of the surface; membrane brownish, transparent: abdomen very thickly and finely punctured on the sides, the middle of the disc, smooth, shining, impunctate; the posterior margins of the segments very minutely denticulated: legs pitchy black, with the tarsi ferruginous: rostrum ferruginous: antennæ ferruginous brown *(Dallas)*. Long, 6¼ mill.

Reported from India ?

Genus CYDNUS, Fabricius.

Pt. Syst. Rhyng. p. 184 (1803): *Cydnus*, Dallas, List Hom. i, p. 110, 120 (1851): Walker, Cat. Het. i, p. 164 (1867): Stål, Hem. Afric. i, p. 18, 19 (1864); En. Hem. v, p. 20 (1876): Sign. pt. A. S. E. F. (6 s.) ii, p. 145 (1882). Includes *Brachypelta*, Am. & Serv., Hist. Nat. Ins. Hém. p. 89 (1843).

Body oval: head produced, semicircularly rounded at the apex and slightly emarginate in the middle, juga longer than the tylus, contiguous at the apex, margins reflexed, remotely ciliated; bucculæ rather elevated, higher posteriorly than anteriorly: first joint of rostrum not extending beyond the bucculæ posteriorly : antennæ 5-jointed, first joint not reaching the apex of the head : the lateral margins of the thorax ciliated : scutellum broader than long, narrow at the apex : frena extended almost to the apex of the scutellum : costal margin of the hemelytra remotely ciliated, apical margin waved : prosternum longitudinally excavated : feet robust, tibiæ spinose, first pair compressed, upper margin spinosely pectinated (*Stål*). Signoret's diagnosis slightly differs as he makes the tylus and juga usually equal in length and bases his differentiation from *Æthus* on the ostiolar canal having at the tip a free lobe, more or less elevated, horn-shaped and more or less flattened on the sides.

44. CYDNUS VARIANS, Fabricius.

Cydnus varians, Fabr., Syst. Rhyng. p. 187 (1803): Stål, En. Hem. v. p. 26 (1876) ; Sign., A. S. E. F. (6 s.) ii, p. 155, t. 6, f. 92 (1882).

Æthus varians, Stål, Hem. Fabr. i, p. 6 (1868).

Cydnus cyrtomenoides, Dohrn, Stettin Ent. Zeit. p. 40 (1860).

♂, ♀. Black-piceous or piceous, basal margin of thorax and feet, paler : membrane sordid whitish : tarsi piceous-whitish : head anteriorly very finely and remotely punctulate : thorax and hemelytra distinctly punctured. In stature like *Æthus indicus*, Westw., but differs in its much smaller size, head more obtuse, anteriorly very obsoletely and remotely punctulate, tylus very slightly narrowed forwards, antennæ much shorter, ocelli situate nearer to the eyes, thorax more narrowed anteriorly, punctuation on thorax, scutellum and hemelytra finer, first pair of tibiæ with fewer spines but apparently longer and the venter remotely sprinkled with fine, obsolete, small punctures (*Stål*). Long, 4 ; broad 2⅕ mill.

Reported from Bengal, Bombay, Ceylon.

45. CYDNUS ATERRIMUS, Forster.

Cimex aterrimus, Förster, Nov. Spec. Ins. p. 71 (1771).

Cimex niger, De Géer, Mém. iii, p. 269 (1773).

Cimex tristis, Fabr., Syst. Ent. p. 716 (1775) ; Ent. Syst. iv, p. 124 (1794).

Cydnus tristis, Fabr., Syst. Rhyng. p. 185 (1803) : Hahn, Wanz. Ins. i, p. 161, t. 25, f. 83 (1831).

Brachypelta tristis, Am. & Serv., Hist. Nat. Ins. Hém. p. 90 (1843).

Cydnus carbonarius, Fourcroy, Ent. Paris (1785) : sec. Sign.

Cydnus spinipes, Schranck, Enum. Ins. Austr. p. 275 (1781).

Brachypelta elevata, Uhler, Proc. Ac. Sci. Phil. p. 222 (1860) ; *Cydnus id*, Stål, En. Hem. v, p. 20 (1876)

Var. (*b*). *Cydnus sanguinicollis*, Fabr., Syst. Rhyng. p. 185 (1803).

Var. (*c*). *Cydnus brunnipennis*, Fabr., l. c. p. 185 (1803).

Brachypeltus aterrimus, Signoret, A. S. E. F. (6 s.) iii, p. 358, t. 9, f. 186 (1883.)

Cydnus aterrimus, Dallas, List Hem. i, p. 12 (1851) excl. syn. pt.; Walker, Cat Het. i, p. 164 (1867): Stål, Hem. Afric. i, p. 19 (1864); Hem. Fabr. i, p. 6 (1868); En. Hem. v, p. 20 (1876).

Black, somewhat shining, densely and distinctly punctulate: membrane whitish hyaline, margined black at the base: thorax in ♂ anteriorly intruded and slightly transversely elevated in the middle (*Stål.*) ♂, ♀, long, 9-13; broad 5-6 mill.

Var. *b.* has the antennæ, and basal limbus of thorax yellow-castaneous. ♂, long 12; broad, 6¼ mill.

Var. *c.* has the antennæ, corium and clavus, yellow castaneous, the corium and clavus infuscate at the base. ♂, long, 9; broad 5 mill.

Oval, elongate, deep black, finely punctured: base of vertex, anterior disc of the pronotum, two basal angles of the scutellum, smooth, the last a little elevated: beneath smooth, shining in the middle, the sides more or less granulated or punctured: feet smooth, shining, sometimes of a lighter colour, femora with several rows of spinose hairs, anterior and middle pair with two spines at the tip: anterior tibiæ strongly amplified, the end having eleven strong spines on the external side and four on the internal side and at the tip, several others on the anterior and posterior disc: trochanters, rostrum and antennæ, piceous. Head longer than broad, margins much raised in front, without hairs on the border and shining only those proceeding from the piliferous points on the vertex and those anterior below the head which spring from each side of the base of the rostrum: the tylus strongly inclosed by the juga: eyes small, without a spine at the base: ocelli very small nearer to the eyes, than to the median line: rostrum short, stout, scarcely extending beyond the anterior coxæ, first joint entirely hidden by the rostral ridges which are rather raised; the second joint stouter, equal to the third, the last one-third less than the preceding: first joint of the antennæ shortest, the third less than the rest, second, fourth and fifth almost equal: anterior border of pronotum strongly emarginate and showing behind the indentation an impression, very strong in the ♂ and less so in the ♀: scutellum triangular, the side hardly shorter than the base, tip angular: hemelytra with 1—3 hairs, external margin very narrow: membrane almost as long as the corium and extending by one-fourth beyond the abdomen, dull plates (*plaques mates*) with the angles rounded and weakly grooved; the glossy parts and grooves closely punctured: *ostiole* ending in a broad, tumid, smooth, shining plate with the posterior convexity circular (*Sign.*). Long, 10—13 mill.

Reported from Europe, Africa, India: specimens from Hardwar (N.-W. P.).

Add perhaps

Cydnus nigritus, Fabr., Ent. Syst. iv, p. 123 (1794); Sign. A. S. E. F. (6 s.), ii, p. 147, t. 6, f. 85 (1882). Reported from China, Cochin-China, Europe.

Cydnus laticeps, Sign., l. c. p. 162, t. 7, f. 98 (1882). Reported from Hong-Kong.

Genus GAMPSOTES, Signoret.

A. S. E. F. (6 s.) ii, p. 243 (1882).

Stenocoris and *Gampsotes* differ from the other genera of *Cydninæ* in the length of the rostrum which reaches the tip of the second segment of the abdomen. In *Stenocoris*, the third joint of the antennæ is much smaller than the second, and the 4-5 joints equal or almost so, whilst the base of the second joint moves in a median groove on the mesosternum. In *Gampsotes*, the second joint of the antennæ is longer than the third, the third is shorter than the fourth which itself is almost as long as the second: the base of the second joint is free, crosier-shaped and slender, further the first joint is only partly hidden by the rostral ridges which leave the apical half of the joint free (*Sign.*).

46. GAMPSOTES PARALLELUS, Signoret.

Gampsotes parallelus, B. S. E. F. (6 s.), i, p. xxix (1881): ii, p. 243, t. 8, f. 103 (1882).

Two and half times longer than broad, parallel, piceous: antennæ especially the joints, and the tarsi ferruginous; rostrum of a lighter colour. Head longer than broad between the eyes, finely punctured, a little ciliated: second joint of the antennæ hardly less long than the third, fourth and fifth longest, the latter longer than the fourth: rostrum very long, reaching the third abdominal segment, second joint arched and somewhat crosier-form at the base, third joint shortest, equal to the first, the fourth slender and long, equal to the second: pronotum strongly emarginate in front and punctured, except on the anterior disc and at the posterior margin, weakly ciliated on the sides: scutellum very long, rounded at the tip, much punctured, except at the basal angles: hemelytra very long; membrane yellow hyaline, extending slightly beyond the abdomen, with four obsolete veins; corium convex at the tip, much punctured, cubital portion with two almost complete rows of points and a third smaller towards the scutellum: feet comparatively short, normally ciliated and spinulose; anterior tibiæ much dilated: ostiolar canal ending in an irregular tuberculous lobe: dull plates *(plaques mates)* occupying almost the entire meso- and metathoracic space and weakly striated: abdomen very rough on the sides and smooth in the middle (*Sign.*). Long, 5½; broad, 2 mill.

Reported from India.

Genus MACROSCYTUS, Fieber.

Eur. Hem. p. 83, 362, (1861): Stål, Hem. Afric. i, p. 19, 23 (1864); En. Hem. v, p. 18 (1876): Sign. A. S. E. F. (6 s.) ii, p. 465 (1882).

Body oval, depressed, ciliated with rare or very rare hairs: head flat, semicircularly or somewhat obtusely rounded; juga and tylus of equal length; bucculæ continued through: antennæ 5-jointed, moderate, filiform, second and third joints somewhat equal, somewhat longer than the basal: scutellum triangular, longer than broad, the frena continued almost to the apex: corium longer than the scutellum, exterior apical angle acute: prosternum longitudinally impressed: feet moderate, tibiæ slender, first pair somewhat compressed, upper margin pectinated with remote spines, last femora beneath armed near the apex with a spine or tooth. Closely allied to *Æthus*, Dallas, differs in having the body very remotely ciliated, margin of the head always without small spines and especially in its habit (*Stål*). Signoret makes the distinguishing characters the large scutellum and especially the presence of a spine at the tip of the posterior femora.

47. MACROSCYTUS FOVEOLUS, Dallas.

Æthus foveolus, Dallas, List Hem. i, p. 113 (1851); Walker, Cat. Het. i, p. 157 (1847); Stål, En. Hem. v, p. 25 (1876).
Macroscytus foveolus, Signoret, A. S. E. F. (6 s.) ii, p. 472, t. 12, f. 131 (1882).

♂. Head rather small, with the anterior margin rounded, entire, the juga not meeting beyond the tylus; pitchy brown, with the margins paler and fringed with fine bristles: ocelli very large, red: thorax pitchy brown, with the posterior margin castaneous, anterior margin with a faint, finely punctured, transverse fovea; lateral margins finely and thickly punctured, and fringed with long, stout, bristles: posterior portion of the disc finely and sparingly punctured: scutellum pitchy brown at the base, becoming castaneous-brown towards the apex, rather strongly but sparingly punctured; the tip with a distinct fovea. Coriaceous portion of the hemelytra bright castaneous-brown, thickly and finely punctured; membrane brownish, semi-transparent: abdomen beneath pitchy, very smooth, shining, with the disc impunctate, the sides thickly and finely punctured: pectus pitchy, thickly and finely punctured: anterior legs pitchy red; four posterior pitchy, with the coxæ reddish; all the tarsi ferruginous: rostrum pitchy red, with the apex pitchy: antennæ ferruginous, dusky towards the base (*Dallas*). Long, 11½ mill.

Reported from N. India.

48. MACROSCYTUS BRUNNEUS, Fabricius.

Cydnus brunneus, Fabr., Syst. Rhyng. p. 185 (1803). Tanger.

Æthus brunneus, Walker, Cat. Het. i, p. 149 (1867) excl. syn. Syria.

Cydnus proximus, Ramb., Fauna Andal. p. 112 (1839). Spain.

Æthus badius, Walker, Cat. Het. p. 159 (1867). India, Ceylon, N. China.

Var. (*b.*) *Æthus opacus*, Stål, Ofvers. K. V.-A., Förh., p. 214 (1853); *Macroscytus id*, Hem. Afric. i, p. 26 (1864); En. Hem. v, p. 19 (1876). Caffraria.

Var. (*c.*) *Cimex spinipes*, Fabr., Spec. Ins. ii, p. 360 (1781); Mant. Ins. ii, p. 172 (1787); Ent. Syst. iv, p. 121 (1794). Cen. Africa.

Cydnus spinipes, Fabr., Syst. Rhyng. p. 186 (1803): Stål, En. Hem. v, p. 25 (1876).

Macroscytus brunneus, Fieber, Eur. Hem. p. 362 (1861) excl. syn. pt.; Muls. and Rey, Pun. Fran. ii, p. 32 (1866), Stål, Hem. Fabr. i, p. 6 (1868): Sign. A. S. E. F. (6s.) ii, p. 477, t. 14, f. 136 (1882).

Stature and size of *C. aterrimus*, Förster, but entirely brunneous and more flat, thorax not retuse nor impressed with a median stria: antennæ 5-jointed: feet spinose: last pair of femora inwardly dentate (*M. brunneus*, Fabr.).

Oval: of a more or less deep brown; the varieties *brunneus* and *opacus*, black and *spinipes* more or less finely punctured: corium sometimes glossy: rostrum, base of antennæ and the tarsi, yellow. Head rounded circularly in front; tylus as long as the juga which have 5-6 hairs along the margin: vertex scarcely carinate: ocelli approximate to the eyes: rostrum reaching the tips of the intermediate coxæ: two first joints of the antennæ, yellow; the third shorter than the second, the fourth and fifth the longest: pronotum convex in front, transversely flattened without an impression; borders slightly margined and with several hairs: scutellum long, reaching three-fourths of the abdomen, angular at the tip which is sloped, convex at the base and on the sides, very finely punctured on the disc: hemelytra almost flat, finely punctured, the radial veins scarcely prominent, the marginal side with 3-6 piliferous points; membrane short, white, hyaline, veins clouded brown: feet obscure, more or less deeply coloured, the tarsi yellow, all the femora spinose beneath, the posterior femora with two stouter spines at the tip which causes the posterior tibiæ to become somewhat distorted at the base, this portion is reddish and glabrous: abdomen black and smooth with some hairs on the margin: ostiolar canal grooved; the tip with two lobes having a broad irregular valvule in the posterior indentation; the dull plates (*plaques mates*) finely striated, the upper rounded at the anterior angle and between it and the mesosternal groove a smooth space which extends to the level of the tip of the ostiolar canal. In var. *opacus*, there is a weak punctuation in the smooth space of the metasternum (*Sign.*). Long, 8; broad, 4½ mill.

Reported from Europe, Africa, Asia: China, Ceylon, India.

49. MACROSCYTUS EXPANSUS, Signoret.

A. S. E. F. (6 s.), ii, p. 479, t. 14, f. 138 (1882).

Body oblong, oval, of a blackish-brown: rostrum, base and tip of the antennæ and the feet of a lighter colour: tarsi, yellow: hemelytra light brown; finely punctured on the posterior disc of the pronotum, the scutellum and the hemelytra. Tylus on a level with the juga which have six hairs; vertex weakly furrowed: third joint of the antennæ shorter than the second: pronotum with 10—11 hairs on the lateral margins; behind the emargination the points are very obsolete: scutellum smooth at the base, sparingly punctured on the disc, tip angular: membrane hyaline; abdomen smooth in the middle, with very fine small striæ, on the sides: the mesosternal dull plate (*plaque mate*) finely striated, rounded at anterior angle, separated from the mesosternal groove by a broad glossy band which is punctured and furnished with small striæ, that of the metasternum is finely striated and punctured: the ostiolar canal ends in a two-lobed part of which the external lobe is broadly dilated and there is a broad rounded valve in the indentation. Possibly only a local variety of *M. brunneus*, Fabr., from which it differs in its appearance but especially in the form of the tip of the ostiolar canal which is here much dilated and is confused with the thickened fold of the mesosternal groove (*Sign.*). Long, 7; broad, 4 mill.

Reported from Bombay.

Genus GEOTOMUS, Mulsant & Rey.

Pun, France, p. 34 (1866); Sign. A. S. E. F. (6 s.), iii, p. 33 (1883).

Differs from *Cydnus* in the absence of small spines on the head. The rostrum is short, usually not extending beyond the intermediate trochanters which distinguishes it from *Gampsotes*: the anterior border of the pronotum is not margined which separates it from *Pangæus*: the absence of the tumidity on the lateral angles of the disc of the pronotum which conceals the real angle as in *Macroscytus* and the posterior femora being spinose at the tip give sufficient characters for distinguishing it. Moreover the ostiolar canal is terminated by a reniform or cornet-shaped lobe *(Sign.)*.

50. GEOTOMUS PYGMÆUS, Dallas.

Æthus pygmæus, Dallas, List Hem. i, p. 120 (1851); Walker, Cat. Het. i, p. 158 (1867); Stal, En. Hem. v, p. 26 (1876).

Cydnus rarociliatus, Ellenr., Nat. Tijd. Ned. Ind., xxiv, p. 139, f. 7 (1862) Vollen., Faun. Ent. Ind. Neerl. p. 18 (1868).

Cydnus pallidicornis, Vollen., l. c., p. 17 (1868).

Cydnus apicalis, Horvath, Hem. Het. récoltés en Chine, p. 3 (1879).

Æthus pallidItarsus, Scott, Hem. Japan, Trans. Ent. Soc. iv, p. 309 (1880).
Geotomus jucundus, F. B. White, A. M. N. H. (4 s.) xx, p. 110 (1877).
Geotomus subtristis, F. B. White, l. c., p. 111 (1877).
Geotomus ? minutus, Motsch., Sign., Ann. Mus. Civ. Gen. xvi, p. 650 (1880).
Geotomus pygmæus, Sign., A. S. E. F. (6 s.) iii, p. 51, t. 3, f. 160 (1883).

♀. Elongate-ovate, black, shining: head with the juga sparingly punctured; ocelli red; thorax smooth, somewhat quadrate, transverse, with a short line of fine punctures close to the middle of the anterior margin, a line of similar punctures across the middle, and a few scattered punctures on the sides, scutellum long, rather thickly and finely punctured, with the base impunctate. Coriaceous portion of the hemelytra pitchy, very thickly and finely punctured, the punctures larger along the veins; membrane whitish; body beneath, black; abdomen thickly and finely punctured on the sides; the disc smooth: legs pitchy; tarsi pale orange; antennæ pale brown, with the tips of the fourth and fifth joints paler or testaceous *(Dallas)*. Long, $3\frac{1}{2}$—$4\frac{1}{4}$; broad, $1\frac{3}{4}$—2 mill.

Reported from India, Sumatra, Java, New Caledonia, Japan, China, Hawaii.

51. GEOTOMUS ELONGATUS, Herrich Schäffer.

Cydnus elongatus, Herr. Schäff., Wanz. Ins. v, p. 97, t. 27, f. 546 (1839).
Cydnus oblongus, Ramb., Fauna Andal. p. 115 (1839); Fieber, Eur. Hem. p. 364 (1861).
Æthus elongatus, Walker, Cat. Het. i, p. 148 (1876).
Geotomus elongatus, Muls. and Rey, Pun. France, ii, p. 35, 38 (1866); Sign. A. S. E. F. (6 s.) iii, p. 212, t. 5, f. 176 (1883).

Body oblong, elongate, parallel on the sides: black-brown, corium a little lighter: rostrum, antennæ and feet, yellow-brown; tarsi yellow: punctured on the head, the posterior disc and the sides of the pronotum, the scutellum (except the basal angles), and the hemelytra. Head rounded in front, tylus as long as the juga and presenting two hairs at the tip, the juga with 4—5 hairs: second joint of the antennæ as long as the third, the fourth and fifth longest: rostrum reaching the base of the intermediate coxæ: pronotum slightly impressed, punctured on the posterior disc, also on the lateral margins and behind the anterior indentation; 7—8 piliferous points on the sides: scutellum long, punctured, angular at the tip, with a longitudinal impression, basal angles smooth: hemelytra punctured, a single piliferous point on the marginal side: membrane white hyaline: abdomen black, smooth in the middle, sides punctured: mesosternal plate extending to the lateral margin, metasternal plate separated from the smooth space which has two rows of dots, by an almost straight line, concave above, convex below: ostiolar canal very rough, narrow at the base, very broad at the tip which forms a much rounded lobe presenting behind a strong excavation in which is hidden the *ostiole* (*Sign.*). Long, 4; broad 2¼ mill,

Reported from Europe, Asia, Africa.

52. GEOTOMUS ABDOMINALIS, Signoret.

A. S. E. F. (6 s.) iii, p. 219, t. 9, f. 184 (1883).

♂. Oval, elongate: pitchy brown, the hemelytra of a lighter colour. Head rounded in front; the tylus broader in the middle than at the tip, as long as the juga and having two hairs at the tip, the juga with five hairs on the margin: vertex finely punctured: the second joint of the antennæ longer than the third: rostrum reaching the level of the intermediate coxæ: pronotum strongly impressed in front behind the anterior indentation and finely punctured in that space also on the transverse line and along the lateral margins; the transverse groove, absent in the middle, is visible on the sides below the piliferous points; lateral margins with five hairs: scutellum long, narrowly rounded at the tip, finely punctured on its disc, basal angles smooth and very convex: hemelytra punctured, corium more sparingly: membrane slightly smoky, hyaline, projecting beyond the abdomen which is smooth in the middle, strongly punctured on the sides: meso- and meta-sternum without dull plates *(plaques mates)*, and both sparingly but broadly punctured: ostiolar canal, broad, short, ending in a broad ear or cornet (*Sign.*). Long, 3½; broad, 2 mill.

Reported from India.

Genus CHILOCORIS, Mayr.

Verh. Zool. Bot. Gess. Wien, xiv, p. 907 (1864); Walker, Cat. Het. i, p. 170 (1867): Stal, En. Hem. v, p. 21 (1876): Sign., A. S. E. F. (6 s.) iii, p. 517 (1883). Includes *Amnestoides*, Sign., B. S. E. F, (5 s.) ix, p. viii. (1880).

Margin of head with erect spinules: tylus as long as the juga: eyes prominent, ocelli distinct: antennæ 5-jointed, second joint scarcely half as long as the third: margin of pronotum anteriorly and on both sides, elevated; scutellum short, triangular, reaching the base of the fourth abdominal segment: odoriferous orifice with a long furrow, with a rounded elevated lobe at the apex: first pair of tibiæ gradually broader towards the apex, externally spinosely pectinated: tarsi inserted at the apex of the tibiæ *(Mayr.)*

53. CHILOCORIS NITIDUS, Mayr.

Chilocoris nitidus, Mayr, Verh. Zool.-Bot. Gess. Wien, xiv, p. 907 (1864): Walker Cat. Het. i, p, 170 (1867); Stål, En. Hem. v, p. 21 (1876): Distant, Trans. Ent. Soc p. 415 (1883); Sign., A. S. E. F. (6 s.) iii, p. 518 (1883).

Shining, piceous-black: posterior margin of the pronotum, hemelytra, antennæ, rostrum and feet, rufous castaneous: head strongly, posterior part of pronotum and hemelytra finely, and the apex of scutellum, punctured; membrane hyaline: abdomen smooth *(Mayr)*. Long, 5 mill.

Reported from Kashmir.

54. CHILOCORIS PICEUS, Sign.

A. S. E. F. (6 s.) iii, p. 518, t. 15, f. 201 (1883).

Blackish-brown, lighter on the corium and on the lateral and posterior margins of the pronotum. Head broad, eyes very stout; ocelli nearer to the eyes than to the median line; vertex with a longitudinal impression; the border of the head, margined: tylus broader in the middle than towards the tip: pronotum strongly margined in front with a longitudinal line and impressions; anterior disc smooth, shining, not punctured (except on the sides which are finely punctured), transverse groove very distinct, with a line of dots; posterior disc weakly punctured: scutellum blunt at the tip, sparingly punctured on the disc, more so but more finely on the lateral margins: hemelytra strongly punctured along the cubital veins with two rows of lines on the clavus, the corium very finely punctured at the tip, almost smooth at the base: membrane hyaline yellow: meso- and meta-sternum dull: ostiolar canal very long but not extending beyond the margin, ending in a lobe truncated at the tip, rounded behind, with a median canal which disappears towards the terminal lobe (*Sign.*). Long, 3½; broad 1¾ mill.

Reported from India. Possibly same as preceding.

55. CHILOCORIS PARUMPUNCTATUS, Sign.

A. S. E. F. (6 s.) iii, p. 520, t. 15, f, 202 (1883).

This species is distinguishable by the serrated margins of the pronotum and of the base of the hemelytra from the teeth of which issue hairs, nine on the pronotum and six on the hemelytra. Light chestnut brown, shining, weakly punctured on the head; tylus very convex and much amplified in the middle, narrow at the tip and on the vertex much broader than the juga: pronotum strongly margined in front, with 3—4 stout points behind the anterior indentation, the anterior disc smooth, shining, longer than the posterior, very convex, and separated from the latter by a strong punctured impression; beyond the groove on the posterior disc are some twelve stouter points and on the groove on each side of the eyes, 3—4 stout points: scutellum blunt, rounded at the tip, sparingly and strongly punctured on the disc, a little more abundantly on the sides: hemelytra sparingly punctured on the corium which is almost smooth, more abundantly along the cubital suture, the clavus showing a complete line along the suture and a half-line near the scutellum; a second line of punctures on the external radial vein and a strong impunctate line, not extending beyond the middle of the hemelytra, on the internal radial vein: membrane hyaline, extending beyond the abdomen which is smooth and shining: meso- and meta-sternum entirely dull: ostiolar canal very long, extending beyond the mesosternum, stout at the source; then narrowing and ending in a rounded lobe which points backwards; in the middle, a narrow groove gradually widened until it is lost in the rounded lobe (*Sign.*). Long, 2¼; broad, 1 mill.

Reported from India.

Sec. II. SEHIRIDES Signoret.

A. S. E. F. (6 s.) i, p. 26 (1881); iii, p. 521 (1883):—*Sehirida*, Stål, Hem. Afric. i. p. 27 (1864).

Without piliferous or setigerous points or dots on the vertex and pronotum in front near the anterior margin and on the disc near the transverse impression and above. These characters are, however, so weak and variable that Stål was probably right in sinking the divisions into *Cydnida* and *Sehirida* made by him in 1864 and including the whole as one sub-family of the Pentatomidæ in 1876 (En. Hem, v. p. 17, 1876).

Genus PELTOXYS, Signoret.

B. S. E. F. (5 s.) x, p. xxxiii (1880); l. c. (6 s.) iii. p. 522 (1883). Includes *Legnotus*, Stål (nec Schiödte), Hem. Fabr. p. 7 (1868); En. Hem. v, p. 22 (1876).

Scutellum short, sides almost equal at the base, tip acuminate; membrane very large, but not projecting beyond the abdomen: rostrum short, scarcely extending beyond the anterior feet: intermediate femora ciliated and with four short spines at the tip; anterior tibiæ a little dilated, the posterior tibiæ straight: ostiolar canal broad, long, with an opening of one half its size *(Sign.)*.

56. PELTOXYS BREVIPENNIS, Fabricius.

Cimex brevipennis, Fabr., Ent. Syst. Suppl. p. 536 (1798).

Cydnus brevipennis, Fabr., Syst. Rhyng. p. 187 (1803).

Æthus brevipennis, Walker, Cat. Het. i, p. 158 (1867).

Legnotus brevipennis, Stal, Hem. Fabr. i, p. 8 (1868); En. Hem. v, p. 22 (1876).

Peltoxys pubescens, Sign., B. S. E. F. (5 s.) X, p. xxxiii (1880).

Peltoxys brevipennis, Sign., l. c. (6 s.) iii, p. 522, t, 15, f. 203 (1883).

♂. Black, shining, above and beneath very densely and distinctly punctured : first joint of the antennæ and the rostrum, piceous : tarsi pale yellow piceous. Tylus remotely punctured towards the base, impunctate before the middle, transversely rugose : thorax in the middle almost twice longer than the head, convex towards the sides, behind the middle, and anteriorly transversely slightly depressed, somewhat convex before the middle, this convex part somewhat depressed in the middle, anteriorly somewhat sloped : clavus with two rows of punctures : corium in the interior part behind the middle with four rows of punctures, towards the base, and on the exterior part sparsely punctured : membrane fuscous, *(Stål)*. Long, 4⅓ : broad, 2 mill.

Reported from Tranquebar, India, Saigon.

Genus TRITOMEGAS, Amyot & Serville.

Hist. Nat. Ins. Hém. p. 92 (1843) : Signoret, A. S. E. F. (6 s.) iv, p. 50 (1884).

Second joint of the antennæ much smaller than the third : *plaques mates* of the episternums small : lobes of the head, unequal or equal which causes the anterior margin to appear more or less emarginate : tylus almost as long as the juga. Head slightly reflexed on the margins and appearing impressed or more or less emarginate in front : pronotum appearing flattened in the margins although really possessing a marginal ridge : median angles of the prosternum less pronounced than in the other genera of this section and therefore the median groove is not so deep : mesosternal ridge indistinct, metasternum smooth : ostiolar canal with an ear-shaped small tongue very distinct, the dull plates *(plaques mates)* weakly developed above and below the mesosternal groove *(Sign.)*.

57. TRITOMEGAS BICOLOR, Linnæus.

Cimex bicolor, Linnæus, Faun. Suec., No. 936 (1761) ; Syst. Nat. ; (ed. 13) p. 722 (1767) ; De Géer, Mem. iii, p. 268 (1773) ; Fabr., Syst. Rhyng., p. 176 (1803 : Wolff, Icon. Cim. p. 63, t. 7, f. 60 (1801) : Stoll, Pun., p. 126, t. 32, f. 224 (1788).

Cydnus bicolor, Hahn, Wanz. Ins. i, p. 192, t. 31, f. 99 (1831).

Cydnus nubilosa, Harris, Exp. Eng. Ins. 90, t. 26, f. 8 (1776).

Sehirus bicolor, Dallas, List Hem. i, p. 129 (1851).

Tritomegas bicolor, Am. & Serv., Hist. Nat. Ins. Hém., p. 98 (1843) Schlb. Mon. Geoc. Fenn. p. 21 (1848) : Sign., A. S. E. F. (6 s), iv, p. 50, t. 2, f. 217 (1884).

More or less oval : bluish-black, shining, punctured, spotted white ; two irregular spots on the anterior angles of the pronotum, two others at the external base of the hemelytra and two not so large at the external angle of the corium : usually also two small white dots at the external angle and at the base of the pronotum as in the type, white : head indented in front, juga with a channeled rim : feet blush-brown, with a more or less broad white ring at the base of the tibiæ :

antennæ brown, second joint shorter than the third, the latter sometimes twice as long as the former: dull plates *(plaques mates)* less developed with some strong, deep points, especially in the mesosternal angle: ostiolar canal very long, projecting beyond the transverse two-thirds of the metasternum *(Sign.)*. Long, 5-7; broad, 2½-5 mill.

Common in Europe and Asia.

IV.—*A second series of New Species of* Ficus *from New Guinea.*—*By* GEORGE KING, M. B., LL. D., F. L. S., *Superintendent of the Royal Botanic Garden, Calcutta.*

[Received March 23rd;—Read April 6th, 1887.]

Since reading my paper before this Society "on some new species of *Ficus* from New Guinea," in January last, I have received from the distinguished botanist and explorer, Signor Beccari of Florence, materials which enable me to describe seven additional new species from that island. The whole of these species were collected either by Sig. Beccari himself, or by his companion Count D'Albertis. These seven species all belong to the third of the sub-groups defined in my paper just referred to, namely, the group characterised by having "unisexual flowers, the males and galls being in one set of receptacles and the fertile female flowers alone occupying another set of receptacles." In this group these seven species are distributed amongst the sections *Sycidium*, *Covellia*, *Eusyce*, and *Neomorphe*, for the distinguishing characters of which I must refer to the paper already mentioned.

SYCIDIUM.

Ficus conspicabilis, King. A tree (?) the young branches and leaf-buds covered with short deciduous yellow hairs; leaves broadly ovate or elliptic, the apex acute or shortly acuminate, the edges entire; the base broad, slightly unequal, sub-cordate, 7-nerved; primary lateral nerves about 6 pairs; secondary nerves sub-transverse, little curved; lower surface pubescent especially on the midrib and nerves, reticulations minute distinct; upper surface minutely lepidote; length of blade about 8 inches; petiole ·8 in.; stipules densely covered with long, yellow, silky hairs. Receptacles large, shortly pedunculate, axillary, solitary, depressed-turbinate, both base and apex very concave, the surface wrinkled, rough, minutely tuberculate, deciduously hispid-tomentose; length from base to apex 1·1 in.; breadth 1·6 in.; umbilicus much depressed, large, with numerous scales; basal bracts 3, broadly triangular; pedicel ·2 in. long, hispid; female flowers sub-sessile or pedicellate, perianth of three distinct dark-coloured pieces; ovary ovoid, smooth; style terminal, longer than the ovary in the sessile, shorter than the ovary in the pedicellate flowers.

New Guinea: Sig. Beccari (Herb. Beccari, P. P. No. 651.)

Ficus mespiloides, King. A tree; the young shoots with long, tawny, adpressed, rather stiff hairs which are ultimately deciduous; leaves hard and rather harsh to the touch, sub-coriaceous, petiolate, elliptic, inequilateral, the apex shortly cuspidate; the edges, entire, recurved; the base narrowed, cordate or emarginate, sometimes oblique, 5 to 7-nerved; primary lateral nerves about 6 pairs, prominent beneath and minutely adpressed-pubescent as is also the midrib; the rest of the under surface puberulous and obscurely and minutely tuberculate; upper surface minutely lepidote, glabrous, rigid; length of blade 5 to 7 in.; petiole scurfy and with a few scattered adpressed fulvous hairs; 4 in. long; stipules ovate, acute, pilose externally, ·4 in. long. Receptacles sessile, axillary, solitary, sub-globose (the base and apex truncate), the surfaces with many faint vertical ridges especially towards the apex, slightly verrucose, when young scurfy pubescent, when mature nearly glabrous; 1 in. long by 1·3 in. broad; the umbilicus large, wide, surrounded by a rigid but in no way projecting annulus; basal bracts 3, leaving an annular scar where they fall off: fertile female flowers ellipsoid, rather flat, smooth, the style long, terminal; perianth of 3 lanceolate, dark-coloured, free pieces; male and gall flowers unknown.

New Guinea on Mount Arfak: Sig. Beccari (Herb. Beccari, P. P. No. 962.)

COVELLIA.

Ficus conora King. A tree, all the young parts softly pubescent, the young branches pale-coloured; leaves petiolate, membranous, elongate-lanceolate, slightly inequilateral, the apex acuminate, the edges entire, the base narrowed, 3-nerved; primary lateral nerves 5 to 8 pairs, slightly prominent beneath and, like the midrib, tomentose; the rest of the under surface pale in colour and (in the adult state) very shortly hispid and minutely papillose (the papillæ white); upper surface covered with very minute white dots but no hairs; length of blade 4 to 7 inches; petioles ·35 in. long, tomentose; stipules lanceolate, pubescent externally, ·6 in. long. Receptacles borne on long, thin, flexuose, leafless, nearly glabrous, branches which issue from the base of the stem, solitary, long pedunculate, turbinate, the apex very broad and depressed, the sides faintly ridged, scurfy-pubescent, and with numerous flat smooth warts, 1 in. across when ripe; umbilical scales large and thick; basal bracts none; peduncle thick, pubescent, bearing 3, small, broadly triangular bracts at or below the middle, varying in length from ·5 in. to 1·25 in.; fertile female flowers pedicillate or sessile, the ovary subglobular, smooth; style elongate, subterminal; receptacular hairs few, pale, long: male and gall flowers unknown.

New Guinea, Ramoi: Beccari (Herb. Becc. P. P. No. 388).

Ternate, Acqui-Conora: Beccari.

The receptacles are often either partially or entirely covered by the soil.

Ficus Arfakensis, King. A tree, the young shoots scurfy and softly pubescent; leaves petiolate, sub-coriaceous, lanceolate, acute, gradually narrowed to the faintly 3-nerved base, edges entire; primary lateral nerves 6 to 8 pairs, obsolete on the upper, prominent on the lower surface, and like the midrib and secondary nerves adpressed pilose, the rest of the lower surface minutely covered with white tubercles, sparsely pilose; upper surface sparsely covered with adpressed whitish hairs: length of blade 4·5 to 7 inches; petiole pilose, ·6 in. long; stipules linear-lanceolate, glabrous, nearly 1 inch long. Receptacles borne on long, ramous, slender branches which emerge from the base of the stem and apparently creep on or beneath the surface of the ground, pedunculate, ovoid, scabrid, slightly verrucose, ·45 in across; umbilical scales numerous, prominent; basal bracts 3, triangular.

Mount Arfak in New Guinea, at from 5000 to 7000 feet above the sea: Sig. Beccari (Herb. Becc. without number).

The receptacle-bearing branches often carry towards their extremities small leaves and modified stipules.

EUSYCE.

Ficus Comitis, King. Young branches glabrous; leaves membranous, elliptic, the apex shortly and narrowly cuspidate, the base broad, 3-nerved; primary lateral nerves about 8 pairs, diverging from the thick strong midrib at a wide angle, prominent on both surfaces but especially so on the lower which is thickly dotted with minute white tubercles; glabrous except on the midrib and primary nerves which are densely and softly puberulous, reticulations minute, very distinct: upper surface glabrous, thickly dotted with tubercles like those on the under surface, but slightly larger; length of blade 4 to 6 inches; petiole from ·75 in. to 1·75 in. Stipules lanceolate, ·6 in. long. Receptacles pedunculate, axillary, in pairs, sub-globose or sub-pyriform, the umbilicus rather prominent, gradually narrowed to the peduncle, adpressed-puberulous, slightly verrucose; about ·25 in. across; basal bracts none; pedicel ·3 in. long, bearing 3 minute bracteoles below its middle.

New Guinea, Andai: D'Albertis (Herb. Beccari, P. Papuanae No. 531).

This has been collected only by Count D'Albertis. Its affinities are with *F. chartacea*, Wall.

NEOMORPHE.

Ficus grandis, King. A tree; the young branches deciduously hispid-tomentose; leaves large, membranous, petiolate, ovate-elliptic, the apex acute, edges irregularly and coarsely crenate-dentate, the base rounded, not cordate, 7-nerved (2 being minute); primary lateral nerves about 8 pairs diverging from the midrib at rather an acute angle; the under surface finely reticulate and with numerous minute white papillae, rather softly and minutely pubescent especially on the midrib and nerves; upper surface scabrous from rather minute sub-adpressed hairs; length of blade 10 to 13 inches; petiole deeply channelled, pubescent, rather stout, 2·5 to 3·5 inches long; stipules ovate-acuminate, smooth inside, puberulous outside, about 1·2 inches long. Receptacles on short, thick, multibracteate, tubercled, leafless branches from the main stem, on long thin peduncles, depressed-globular or shortly pyriform, the surface slightly verrucose and scurfy but without hairs, red when ripe; 1·4 in. long and 2 inches broad; the apex very broad, flat, slightly depressed; umbilical scales numerous, prominent; basal bracts 3, large, ovate-triangular, acuminate, glabrous; peduncles nearly 3 inches long: male flowers with 1 or 2 stamens; anther ovate, on a thick filament; perianth of 3; obcordate, inflated, hyaline, pieces: gall flowers pedicillate or sessile, the style sub-terminal, perianth absent; fertile female flowers unknown.

New Guinea: Sig. Beccari (Herb. Becc. No. 601).

This vies with *F. Roxburghii*, in having the largest leaves and receptacles of any Asiatic member of the genus *Ficus*.

Ficus D'Albertisii, King. A tree; the young branches with annular swellings at the nodes, completely covered with closely adpressed, minute, rusty, pubesence; leaves broadly ovate or elliptic, sometimes obovate-elliptic, the apex acute, shortly cuspidate, the edges minutely dentate or sub-entire; base rounded, emarginate, or sub-cordate, sometimes unequal, 5-nerved; primary lateral nerves about 7 pairs; both surfaces closely covered with very minute adpressed hairs, the upper surface slightly harsh, the lower soft; length of blade about 9 inches, petiole about 1·5 in., pubescent, swollen at its insertion on the stem; stipules ovate-lanceolate, acuminate, adpressed-pubescent externally, 1·5 in. long. Receptacles in small clusters from leafless ebracteate tubercles on the stem, pedunculate, pyriform, the sides with numerous vertical ridges and clothed with short adpressed, apparently deciduous, scurfy pubescence; length 1·2 in., breadth 1 inch; the umbilicus large, closed by 5 broad, rounded scales; basal bracts 3, ovate, deciduous; peduncle stout, glabrous, ·75 in. long; female flowers sessile or pedicillate, slightly rugose, the style long, terminal, hairy: male and gall flowers unknown.

Fly River, New Guinea, D'Albertis: (no number). Sumatra, Beccari: (Herb. Becc. P. S. No. 736.)

V.—*On some New Species of* Ficus *from Sumatra.—By* George King, M. B., LL. D., F. L. S., *Superintendent, Botanic Garden, Calcutta.*

[Received April 1st;—Read April 6th, 1887.]

Amongst the collections of dried plants made by Mr. H. O. Forbes, during the journey in Eastern Sumatra of which an account is given in his interesting volume entitled, 'A Naturalist's Wanderings in the Eastern Archipelago,' I find four undescribed species. Three of these belong to the section *Covellia*, and one to *Eusyce.* They are as follows:—

Covellia.

Ficus brachiata, King. A tree, the young shoots adpressed-pilose: leaves thinly coriaceous, inequilateral, elliptic-lanceolate, the apex acute or shortly acuminate, the edges entire or sometimes irregularly and minutely undulate; base acute, obscurely 3-nerved; lateral primary nerves 8 to 10 pairs, sub-horizontal, rather prominent beneath and adpressed-pubescent, as are the midrib and secondary nerves, the rest of the lower surface puberulous or glabrous, the reticulations minute, indistinct; upper surface glabrous; length of blade 4 to 5 inches; petiole ·5 in. long; stipules 1 in. long, glabrous. Receptacles borne on long leafless, glabrous, very ramous branches which issue from the stem near the ground, pedunculate, turbinate, verrucose, puberulous, about ·5 in. across; the umbilical scales numerous and prominent; basal bracts 3, broadly ovate; peduncle ·35 in. long; male and gall flowers not seen: fertile female flowers mostly sessile, without perianth, the style elongate, terminal and straight in young, lateral and curved in old, ovaries.

Mount Dempe, Eastern Sumatra, at elevations of about 4500 feet: Mr. H. O. Forbes (Herb. No. 2313).

This approaches *F. Miquelii*, but has smaller, narrower leaves; the receptacles are also smaller and borne on much longer branches.

Ficus Forbesii, King. A tree, the young branches, petioles and midribs of the leaves covered with dense short tawny tomemtum; leaves thickly membranous, shortly petiolate, elliptic or obovate-elliptic, the apex suddenly and shortly cuspidate; gradually narrowed from above the middle to the blunt, 3-nerved base; the edges entire; primary lateral nerves 12 to 20 pairs, prominent on the lower surface as are the midrib and straight transverse secondary nerves, the whole of the rest of the lower surface sparsely covered with stellate tawny hairs; length of blade 12 to 15 inches; petiole stout, ·25 in. long. Receptacles in lax umbels from long, leafless, glabrous, little divided branches which issue from the stem near its base, pedunculate, globose, glabrous, ·25 in. across, slightly umbonate at the apex, the base constricted into a short stalk at the junction of which with the peduncle proper are 3 ovate acute bracts; male and gall florets not seen; female flower without obvious perianth; ovary obovate, about half as long as the style.

Sumatra, Mr. H. O. Forbes (Herb. Forb. without number).

The receptacular branches ramify very little; at their apices there are whorls of stipule-like, lanceolate, bracteoles. The stellate pubescence is very peculiar. This species comes very near *F. ribes*, Reinw., from which it differs chiefly in its leaves. The female flowers of this are exactly like those of *F. ribes.* I have been able to find no male flowers, and I think it probable that, like *ribes*, this species is practically dioecious, male flowers occurring only in the receptacles of certain individual trees. The species is known only from Mr. Forbes's specimens, which were probably all collected from one tree.

Ficus dimorpha, King. A small tree, the young shoots deciduously hispid-tomentose; leaves petiolate, sub-coriaceous, inequilateral, elliptic or obovate-elliptic; the apex acute, shortly cuspidate; the edges rather remotely dentate; the base rounded, slightly auricled on one side, 3-nerved, with an additional minute nerve on the auricled side; primary lateral nerves 6 or 7 pairs, not prominent; the under surface dull, harshly pubescent, especially on the midrib and nerves, the reticulations indistinct; upper surface glabrous and shining; length of blade 4·5 to 6 inches; petiole ·5 to ·75 in., pilose; stipules ovate-lanceolate, slightly pubescent externally, ·7 in. long. Receptacles pedunculate, in small fascicles from the stem and larger branches, of two forms (*a*) those containing gall and male flowers which are pyriform, truncate at the apex, gradually constricted at the base into a long, thin, stalk at the union of which with the peduncle proper are 3 deciduous bracts, wrinkled, verrucose, pubescent; total length 2·5 inches, of which the stalk forms more than half; breadth at apex 1 inch, peduncle proper 5. in., male flowers numerous under the bracts of the mouth, stamen 1;

perianth of 3 concave pieces; gall flowers elongate, with a short, sub terminal style; perianth 3-cleft; (*b*) those containing female flowers which are turbinate, the apex concave and the umbilicus depressed, the base constricted into a stalk ·4 in. long, length 1 in., breadth 1·3 in., peduncle proper ·2 in. long; fertile female flowers pedicillate, the achene ovate-rotund, perianth undivided or splitting irregularly.

Mount Dempe, in Eastern Sumatra, at an elevation of about 3000 feet; Mr. H. O. Forbes, Herb. No. 2175.

The elongate receptacles occur mostly on the stem, the globular on the branches. The former contain perfect male flowers, scales with rudimentary anthers, and gall flowers: the latter perfect, fertilised, female flowers.

EUSYCE.

Ficus dumosa, King. A shrub 3 to 9 feet high; leaves long-petiolate, membranous, from ovate-elliptic, acuminate, (rarely sinuate) to palmate, with from 3 to 5 deep acuminate lobes, edges of all the forms irregularly dentate, the apices of the lobes cuspidate, base cordate or rounded, sometimes sub-auriculate, 5 to 7-nerved; upper surface scabrid-papillose, each papilla bearing a stiff hair, the nerves tomentose, hispid; under surface more sparsely hispid, hirsute on the nerves; lateral primary nerves 5 to 6 pairs; reticulations distinct; length of blade 5 to 9 inches; petioles slender, hispid, from 2 to 4·5 in. long; stipules lanceolate, hispid at first, subsequently glabrous, about ·8 inch long; receptacles axillary, sessile, in pairs, depressed globose, with a small few-bracted umbilicus, sparsely hispid when young, smooth, scarlet to lake red when ripe, and from ·5 to 1 in. across; basal bracts 3, minute, ovate, spreading; male flowers on the receptacles with the gall flowers and near the mouth only, the perianth of four broad distinct pieces, stamens 2 perfect, or sometimes only, perfect stamen with a rudimentary pistil: gall flowers pedicillate or sub-sessile, the perienth of 5 lanceolate, free pieces; ovary globose, smooth; style short lateral, stigma infundibuliform; fertile female flowers in distinct receptacles, sub-sessile or pedicillate, perianth as in the gall flowers; achene obliquely ovoid, slightly viscid, minutely tuberculate, the style elongate, lateral: stigma pyramidal.

Kaiser's Peak, Mount Dempe, and other hills in Eastern Sumatra from 2000 to 6000 feet, Mr. H. O. Forbes (Herb. No. 2291).

This is closely allied to *F. alba*, Reinw., but it is well distinct, differing from typical *alba* by its larger receptacles, longer petiolate, thinner, leaves, which are sparsely hispid on both surfaces and not tomentose below. I have not been able to find male flowers.

VI.—*On the Mammals and Birds collected by* Captain C. E. Yate, C. S. I. *of the Afghan Boundary Commission.—By* J. Scully.

[Received May 30th;—Read June 1st, 1887.]

Mr. Wood-Mason has asked me to contribute a paper on the collection of mammals and birds made by Captain C. E. Yate in Northern Afghanistan and presented by that officer to the Indian Museum; the following notes are the result. The collection, I understand, was made after the departure of the Naturalist of the Commission, so it may possibly include some forms not secured by him, and doubtless additional localities will now be made known for many of the species previously obtained.

The collection contains 13 species of mammals and 110 species of birds, those comprised in the first class being particularly interesting. I have carefully examined every specimen entered in the following lists, and the identifications are as accurate as I can make them with the rather limited means of effecting comparisons. The localities and dates are carefully entered by Captain Yate on every ticket and most of the specimens of birds are sexed also; but I have found so many errors in the sexing of the birds that I have thought it best to omit this part of the record. When I have noted the sex, I am responsible for the entry.

I have to express my thanks to Mr. Wood-Mason for giving me access to the collections under his charge at all sorts of unofficial hours, for permitting me to take most of Captain Yate's collection to my house for identification, and for procuring for me from many quarters sundry works for reference.

MAMMALIA.

1. Erinaceus albulus, Stoliczka.

1. Maruchak, Murghab, Herat, May 23.
2. Badghis, Herat.

This Hedgehog agrees well with typical examples of the species to which I have referred it, from Yarkand. The fur on the whole lower surface of the body is white, the head and cheeks are pale rufescent fawn, the ears pale isabelline behind and white in front; the hands and feet are brown above, with a few white hairs intermixed. There is no nude area on the vertex; the spines measure 0·8 to 0·9 inch and have two dark and two pale bands, the tip being pale. Length of ear in front, from orifice, 1·45; fore foot 0·85, with claws 1·02; hind foot 1.4, with claws 1·53; tail 0·8. Teeth: $\underline{i.\ 2}$ half the size of $\underline{i.\ \ 3,}$ $\underline{\ c.\ }$ has two fangs anterior and posterior, $\underline{pm.\ 1}$ two distinct fangs, $\underline{pm.\ 2}$ three fangs, two buccal and one palatine. ***E. albulus*** seems quite distinct from ***E. auritus*** with which I have compared it.

2. FELIS CAUDATA (Gray).

1. Maimanab.

A flat skin, without skull. Nose to insertion of tail about 29·5 inches, tail about 13, hairs at tip of tail 0·7, ear from orifice at front 2·2, longest whisker 3·5, palma 3·2, planta 1·4. The ears are pointed, with a small tuft of hair at the apex measuring about 0·25. The general colour of the fur is, above, a pale yellowish grey with dusky streaks mainly along the centre of the back from nape to root of tail. Below, the fur is creamy white with dusky spots showing through here and there. The fur is soft and moderately long, grey at the base all over the body, then isabelline, and, where dark markings appear on the surface, the tips of the hairs are blackish. The head is grizzled grey, darker than the back, the sides of the nose pale fulvous, the cheeks white. The ears are pale isabelline behind, brown at the tips, and inside the hairs are whitish. The limbs are pale yellowish grey in front, with faint dusky markings near the body; inside whitish except the plantar and palmar surfaces, which are brownish black. Tail above on proximal half fulvous grey with dusky dashes resembling the back, below whiter and almost free from dark markings like the belly; rest of tail greyish white with four black rings and a black tip 1 inch long. This specimen is closer to *F. caudata* than to any other species with which I am acquainted, but from want of specimens for comparison, and in the absence of the skull, I cannot feel certain that the identification is correct.

3. CANIS LUPUS, Linn.

1. Afghan Turkistan.

A flat skin, without skull. Nose to root of tail 37·5 inches, tail 12, hair at end of tail 2·5, ear from orifice in front 3·8. There is no black on the ears or the hind limbs; the fore limbs have a narrow black stripe down the front, ending about six inches above the point of the toes. Down the middle line of the back and along the upper surface of the tail the hairs are mainly black, and the tip of the tail is quite black.

4. VULPES MONTANA, Pearson.

1, 2. Afghan Turkestan.

These are again two flat skins without skulls. From nose to root of tail they measure about 29 and 31 inches, tail 15·5, hairs at end of tail 2·5. The face is rufous with the usual dark patch below the eye, the ears are wholly black behind, the ordinary dark cross on the shoulders is present, and the tail tip is white. One skin has the greater portion of the front of the fore limbs black; in the other this part is rufous; in both specimens the underparts are grey. In the larger animal, probably a male, the fur is much longer and softer, and the tail more bushy than in the other; and the claws, which in both are unusually large, curved, and sharp-pointed, are more powerful. Both these skins can be fairly matched in the large series of *V. montana* which I collected in Gilgit, and to that species I accordingly refer them.

5. SPERMOPHILUS BACTRIANUS, sp. nov.

1. ♀ Khamiab, Afghan Turkestan, June 12.

Ear conch rudimentary, soles of hind feet densely haired, tail short, not longer than hind foot, hair on body harsh, very short, unicolor.

Head and body (from skin) 9·5 inches, tail 1·5, with hairs at end included 2·2, fore foot without claws 1·25, hind foot without claws 2·25. On the head and whole body above and below the hair is very short, harsh, closely adpressed, and of the same colour throughout from base to tip. Upper parts nearly uniform pale fawn, the head slightly darker and more brown, and the rump more tinged with rufous; a pale isabelline band, from nostril to eye. Tail like the rump with a black subterminal ring and pale fulvous tip. Edges of lips, chin, throat, and whole lower surface, including inner aspect of limbs, creamy white. Outer aspect of limbs bright fulvous; upper surface of fore and hind feet pale isabelline, below to root of digits covered with creamy white hairs. The outer toe has a long pencil of whitish hair on its under surface which exceeds the tip of the claw by about half an inch. The vibrissæ are long, fine, and mostly brown; and a pencil of long glistening white hairs grows below the chin. The claws are black with pale horny tips. There are three pairs of mammæ. The skull is imperfect behind and its total length cannot be given; the posterior end of the nasals extends further back than the termination of the premaxillæ :—

	Inch.
Greatest breadth of zygoma,	1·3
Breadth of brain case behind postorbital processes,	0·78
Length of nasals,	0·8
Breadth ,, behind,	0·2
,, ,, in front,	0·26
Premolar to symphysis of premaxillæ,	0·6
Posterior margin of palate to incisors,	0·98
Breadth of palate between pm. 2,	0·27
Length of mandible, condyle to symphysis,	1·3

From the characters already given for this souslik, it could not be referred to any species of *Spermophilus* belonging to the section in which the hind feet are not haired below, *e. g.*, *S. fulvus*, *S. rufescens*, *S. erythrogenys*, *S. brevicauda*, *S. mugosaricus*, *S. concolor*, or *S. musicus*. Of the section having well-haired soles, *S. eversmanni* and allies are also excluded by the length of the tail ; Middendorff gives the length of tail in *S. eversmanni* as 4·2 inches, with terminal hairs 5·5. Of the short-tailed sub-section, *S. citellus*, *S. dauricus*, *S. guttatus*, *S. xanthoprymnus*, and *S. mongolicus* are excluded for various, but good and sufficient, reasons which to enumerate would be long. The only likely species that remains is *S. leptodactylus* of Lichtenstein, and, to it, I was at first disposed to refer the specimen collected by Captain Yate. The position of Lichtenstein's species is, in the first place, involved in doubt : it was distinctly described as having the hind feet haired below, but, according to Brandt (Bull Acad. Sc. St. Petersburg II, p. 359), Eversmann proved to his satisfaction that *S. leptodactylus* was the same species as *S. fulvus*, which has the soles bare. However this may be, I have carefully compared Lichtenstein's detailed description of his *Citillus leptodactylus* (Säugethiere, Tab. XXXII.) with the specimen under notice and can only come to the conclusion that the latter is perfectly distinct, even if the question of hair on the soles be left out of consideration. In describing this species as new I have not overlooked Brandt's caution about the young of bare-soled sousliks having sometimes that part tolerably well covered with hairs.

6. GERBILLUS, sp.

1. ♂ Balkh, Afghan Turkistan, July 4.

Head and body about 5·4, ear at front from orifice 0·6, fore-foot 0·38, with claws 0·45, hind foot 1·2, with claws 1·3. Fur long, fine, and very soft. Bright rufous brown or fawn colour above, many of the hairs black tipped, the basal parts of the hair leaden grey ; below the hairs white throughout their length. Ears fairly well haired, fawn-coloured behind with a white margin, in front with scanty white hairs at the margins ; whiskers white. Fore limbs white above and below, the palms naked ; hind feet isabelline above, with whitish hairs on the the soles, including the toes, except part of the hinder portion of the tarsus. The tail is imperfect, but its basal part for about 2·5 inches is coloured like the back above, and is slightly paler below.

The upper incisors are well grooved, the enamel folds of the upper molars are completely united in the middle, exactly as in *G. hurrianæ*, and the hinder molar has not a vestige of any posterior talon—the outline of the crown as seen from above being simply a narrow oval, with the points of the oval buccal and palatine. The following are the principal measurements of the skull:—

	Inch.
Total length,	1·58
Breadth of zygomatic arch,	0·85
,, of brain-case at posterior root of zygoma,	0·69
Length of palate to incisors,	0·69
,, of nasals,	0·6
Mandible, condyle to symphysis,	0·78

Although the upper molars agree best with those of *G. hurrianæ,* this specimen is quite different in character and colour of fur and in shape of skull; neither can it be referred to *G. erythrurus* with which I have compared it. It possibly represents a new species, but, as the tail is imperfect, I do not propose a name for it.

7. MUS BACTRIANUS, Blyth.

1. ♂ Chahar Shamba, Maimanah, April 4.

This specimen agrees fairly well with typical examples of *M. bactrianus,* but the tail is shorter than the head and body, though this is not of importance in a skin. In comparing this specimen, I have had occasion to examine many specimens of *M. pachycercus* Blanford, from Yarkand, and I may note that that species is quite distinct from *M. bactrianus* and has been happily named.

8. ARVICOLA GUENTHERI, Danford and Alston.

1. Afghan Turkestan.

Head and body 4·4 inches, hind foot 0·77, ear at front 0·4. The external form and colours agree well with the original description of the species from Asia Minor (P. Z. S. 1880, p. 62), except that in this specimen the rudimentary thumb of the forefoot has a small nail. The pattern of the molar teeth is very similar to that of *A. guentheri,* with the following exceptions:—

In this specimen $\underline{m.1}$ has not the rudimentary 4th angle on the inner side so prominent; it is barely indicated. On $\underline{m.2}$, however, this posterior inner angle is distinct and must be counted, although in the original description above cited it is omitted. $\underline{m.3}$ has the posterior lobe less prolonged backwards and tends less to form an angle on the outside than in the Asia Minor species. $\overline{m.1}$ too has the anterior lobe more compressed laterally in the present specimen. The following table exhibits the molar pattern according to the usual mode of counting:—

	Spaces.	External angles.	Internal angles.
$\underline{m\ 1}$	5	3	3
$\underline{m.\ 2}$	4	3	3
$\underline{m.\ 3}$	6	3	4
$\overline{m.\ 1}$	9	5	5
$\overline{m.\ 2}$	5	3	3
$\overline{m.\ 3}$	3	2	3

9. Ellobius intermedius, sp. nov.

1.	Bokun,	Murghab,	Herat,	May 10.
2.	Kila Wali,	ditto	ditto	May 14.
3.	Ditto	ditto	ditto	May 26.

Head and body (from skins) 4·5 to 5 inches, tail 0·4 to 0·45, hind foot 0·8 to 0·9, forefoot 0·55 to 0·67. Colour above, and on sides of head below the zygomatic projection, bright pale yellowish red (or bright rust colour). Head dark brown. Below greyish white throughout. Tail pale fulvous, the terminal hairs at tip white. Fore and hind feet whitish. Fur short (about 0·35 on hinder part of back), very soft and fine dark grey or leaden at the base, except on centre of belly, where it is white throughout its length. The bright colour of the upper surface being due to the short pale coloured tips of the hair, any abrasion of these gives the animal a dark leaden grey colour above.

Skull :—	Inch.	mm.
Breadth across hinder part of zygomatic arches,......	1·05	27
„ of interorbital constriction, ...	·21	5·5
„ of brain-pan behind posterior termination of zygoma, ...	·62	16
Length from anterior molar to incisors, ...	·54	14
„ of upper molar series,............................	·32	8
„ of palate to incisors, ...	·86	22·5
Breadth of palate between anterior molars, ...	·14	4
Length of lower jaw, condyle to symphysis,............	1·05	27
„ of lower molar series,............................	·33	8·5

The nasals are shaped somewhat like a wine-bottle bent in at the sides, their external margins being nearly straight behind, then convex, then strongly concave, and finally convex again at the front end; the posterior ends are pointed, not truncated. The posterior ends of the premaxillæ extend quite 3·5 mm. behind the ends of the nasals and the same distance beyond the origin of the zygomatic arch. The zygomatic arch is high throughout; the maxillary process does not reach the squamosal along the lower margin, a square process from the malar interposing itself and forming the lower edge of the arch for a length of 1·5 mm.

The skull differs from that of *E. fuscocapillus* in having the nasal portion shorter, the distance from anterior root of zygoma to symphysis of premaxillaries being 15 mm. in *E. fuscocapillus* against 12 mm. in the present species; the zygomatic arch is quite differently shaped, being higher throughout, and the malar bone forms part of the lower margin, while in *E. fuscocapillus* the maxillary and squamosal processes meet along the lower margin, so as to exclude the malar; and the anterior palatine foramina are much smaller and narrower.

From *E. talpinus*, the skull of the present species differs completely in the shape of the nasals and in the extension backwards of the end of the premaxillæ; the shape of the zygoma presents even a greater divergence than from *E. fuscocapillus*, but the arrangement of the bones in the arch are closely similar in *E. talpinus* and *E. intermedius;* the anterior palatine foramina are very much smaller than in *E. talpinus*, and there are other differences which will be apparent on studying Mr. Blanford's very clear account of the contrast between the skulls of *E. fuscocapillus* and *E. talpinus* in J. A. S. B., vol. L, pt. II, 1884, pp. 122 –123.

Teeth. The incisors are very long and pure china-white. The molar pattern is as follows:—

	External angles.	Internal angles.
$\underline{m.\quad 1}$	3	3
$\underline{m.\quad 2}$	3	2
$\underline{m.\quad 3}$	3	2
$\underline{m.\quad 1}$	4	5
$\underline{m.\quad 2}$	3	3
$\underline{\quad 3}$	3	3

$\underline{m.\quad 1}$ and $\underline{m.\quad 2}$ do not differ from the corresponding teeth in *E. fuscocapillus* and *E. talpinus* in any important particular. $\underline{m.\quad 3}$ differs markedly from the corresponding tooth in *E. fuscocapillus* and resembles that of *E. talpinus* in wanting a posterior lobe behind the hindmost outer angle; both the internal angles too are less prominent in the present species, the last angle being much rounded.

In $\overline{m.\quad 1}$ the anterior lobe is less developed than in *E. fuscocapillus*, but still there are 4 external and 5 internal angles, not 3 and 4 as in *E. talpinus*.

The three species of *Ellobius* may be thus contrasted :—

E. talpinus.	*E. intermedius.*	*E. fuscocapillus.*
1. Base of fur almost black.	1. Base of fur dark or leaden grey.	1. Base of fur light grey.
2. Zygoma low, malar interposed between maxillary and squamosal processes in lower margin.	2. Zygoma high throughout, malar interposed between maxillary and squamosal processes in lower margin.	2. Zygoma high in middle, maxillary and squamosal processes alone form lower margin.
3. Nasals convex externally.	3. Nasals bottle-shaped, or external margin alternately convex and concave.	3. Nasals bottle-shaped, or external margin alternately convex and concave.
4. Premaxillæ terminate posteriorly opposite end of nasals.	4. Premaxillæ prolonged behind hind end of nasals.	4. Premaxillæ prolonged behind hind end of nasals.
5. $\frac{m.\,3}{\quad}$ has no posterior lobe behind last outer angle.	5. $\frac{m.\,3}{\quad}$ has no posterior lobe behind last outer angle.	5. $\frac{m.\,3}{\quad}$ has a prominent posterior lobe behind last outer angle.
6. $\frac{\quad}{m.\,1}$ angles 3—4.	6. $\frac{\quad}{m.\,1}$ angles 4—5 ...	6. $\frac{\quad}{m.\,1}$ angles 4—5.

For the comparison of the three specimens collected by Capt. Yate, I have Mr. Blanford's very full description of a skin and skull of *E. fuscocapillus* (with figure of skull and teeth) in the paper before cited, and three skins and a skull of the same species in the Indian Museum. I have no specimen of *E. talpinus* for comparison, but Mr. Blanford has so clearly and, I am sure, accurately given the differences between that form and *E. fuscocapillus* that I have no hesitation in deciding that Capt. Yate's specimen must be referred to a new species. The only known locality for *E. fuscocapillus* is Quetta, and the Russian *E. talpinus* is recorded by Severtsoff from Western Turkestan; so that the present species is intermediate in its habitat, as well as in its distinctive characters, between the two better known species of the genus. Severtsoff calls his Turkestan specimens *E. talpinus*, var. *rufescens*, and these may prove to belong to the species I have described.

Capt. Yate notes on the ticket of one of the specimens, "Eyes scarcely visible; caught by day."

10. LAGOMYS RUFESCENS, Gray.

1. Shadian, Afghan Turkistan, August 2.
2. Ditto ditto ditto, August 6.

The above two examples belonging to a well marked and well known species need no extended notice; they agree perfectly with specimens collected by Blanford in Persia. The species was originally described from a specimen obtained in Afghanistan.

11. LEPUS LEHMANNI, Severt.

1. **Hindu Kush, Afghan Turkistan.**

This specimen is not in very good order, and I refer it rather doubtfully to the species described by Severtsoff (*see* Ann. & Mag. Nat. Hist. 1876, "The Mammals of Turkistan"), with which on the whole it seems to agree best. So many species of Asiatic hares have been described which differ only in minute particulars as to make the task of identifying a particular specimen difficult and uncertain; for the number of nominal species probably greatly exceeds the constantly distinguishable forms. In the specimen obtained in the Hindu Kush the ears measure from orifice in front about 4·3 inches, at back 4·8, greatest breadth about 2·7. The anterior external part of the ear is coloured like the back; the posterior part being pale isabelline, black at the tip and partly down the posterior margin.

The general colour above is mixed pale fawn and black. The chin and belly are white and the throat and breast pinkish isabel. The basal part of the fur above and where coloured on the limbs and breast is grey; on the belly the fur is white throughout its length.

The premaxillaries end behind on a level with the nasals, the latter bones having the posterior end sloping inwards and the junction of their outer and hinder margins slightly rounded.

The mandible from condyle to symphysis measures 3·4 inches.

12. GAZELLA SUBGUTTUROSA, Guldenst.

1. ♂ **Badghis, Herat.**

Head and horns, with skin of head preserved. Band from between horns to nostrils rufescent fawn. A pale isabelline band outside this from level of inner canthus of eye to upper lip. A dark rufous fawn stripe from eye-pits to commissure of lips. The ear measures about 5·25 inches in length from orifice to tip in front. The horns from the base curve outwards, forwards, then backwards, and at the tips they curve inwards and forwards. There are 20 rings on each horn, and these end about 2·5 inches from the tips. The horns measure 14·7 inches in length along the curve in front, the distance of the tips apart is 6·9, the greatest distance apart 7·5, and the girth at the base about 4·5.

13. CERVUS CASHMIRIANUS, Falconer.

1. **Banks of Oxus near Balkh, Afghan Turkistan.**

This is a cast left antler of an elaphine stag about which Capt. Yate gives the following information, "This was a horn from the banks of the Oxus near Balkh and will help to determine the identity of the deer found in the jungles along that river." The antler is not perfect, as the beam is broken above the royal, so that the form of the crown cannot be ascertained; the following are the measurements :—

	Inches.
Length from burr to broken end of beam along curve inside,	17·8
„ of brow tine, about,	4
„ of bez tine, about,	7
„ of royal tine along curve, about,	7·7
„ of beam above upper angle of royal,	6·9

Viewed in front, the beam is nearly straight (though of course inclined outwards) as far as the royal, where it begins to curve inwards. Viewed from the outer side, it curves slightly back from the bez and forwards to the origin of the royal; above the royal, it curves gently back and then forwards and inwards. The brow tine is straight and directed somewhat upwards: the much longer bez is directed outwards and upwards, and towards its tip it has a slight curve inwards; the royal is directed first outwards, then it curves at about 3 inches from the beam strongly upwards and inwards, the point being well inside the line of the broken end of the beam. Without measurement, the bez looks longer than the royal, and the middles of the bez and brow tines, measured along the middle line of the beam, are 2·5 inches apart, or from upper margin of brow to lower margin of bez at junction with beam about 1·7 inches.

It is quite clear I think that this antler agrees better with that of *C. cashmirianus* than with that of any other deer to which it could be referred. It is quite distinct from *C. maral*, as figured by Sclater in Trans. Zool. Soc., Vol. VII. I may mention that Mr. Wood-Mason, who examined this horn before I saw it, came to the conclusion that it must be referred to *C. cashmirianus.* Of course the evidence of such a fragment is not conclusive proof that the stag of the Oxus basin is really identical with the Kashmir species; complete specimens are necessary for the settlement of that point.

AVES.

1. CIRCUS CYANEUS, (Linn.).

1. ♀ Zulfikar, Badghis, Herat, November 25.
2. ♂ Chahar Shamba, Maimanah, February 1.
3. ♀ Maruchak, Murghab, Herat, March 13.
4. ♂ Maruchak, ditto ditto March 10.

The males are in immature plumage; one is noted as having the iris yellow. A female, not adult, had the irides dark brown.

2. CIRCUS MACRURUS, (Gmel.).

1. ♂ Maruchak, Murghab, Herat, March 18.

Adult, wing 13·7, iris yellow.

3. CIRCUS CINERACEUS, (Mont.).

1. ♂ Karawal Khana, Murghab, Herat, April 17.

In adult plumage, but with chestnut streaks on belly and flanks.

4. CIRCUS ÆRUGINOSUS, (Linn.).

1.	♂	Maruchak,	Murghab,	Herat,	March	12.
2.	♂	Karawal Khana,	ditto	ditto,	April	16.
3.	♀	Kila Wali,	ditto	ditto,	May	13.

5. SCELOSPIZIAS BADIUS, (Gmel.).

1. Chahar Shamba, Maimanah, February 13.

In immature plumage; wing 8·75 inches, tail 5·6, tarsus 1·52, mid toe *s. u.* 1·32; seven bars on the tail.

6. ACCIPITER NISUS, (Linn.).

1. Hauz-i-Khan, Badghis, Herat, December 6.

In rather dark plumage; four bands on tail; wing 9·4 inches, tail 7, tarsus 2·35, mid toe 1·6. The specimen is marked male on the ticket, and, if correctly sexed, may be referable to subspecies *A. melaschistus.*

7. BUTEO FEROX, (Gmel.).

1.	♂	Chahar Shamba,	Mainmanah,	January	27.
2.	♂		Mainmanah,		
3.	♀	Chahar Shamba,	ditto.	February	4.
4.	♀	Kara Bel,	ditto.	March	10.

In all, the tarsi are scutellate in front, the bare portion measuring from 1·8 to 2 inches; the males have the wings 15·9 and 16·5 and the females, 17·1 and 17·8; in the four specimens, the tarsi measure 3·2 to 3·3 and the mid toe 1·5 to 1·6.

8. MILVUS MIGRANS, (Bodd.).

1.	Chahar Shamba,	Maimanah,		April 4.
2.	Karawal Khana,	Murghab,	Herat,	April 9.
3.	Ditto	ditto	ditto,	April 9.

The wings measure 17 and 18 inches.

9. TINNUNCULUS ALAUDARIUS, (Linn.).

1. Jan. 21; 2. Feb. 4; 3. Feb. 7; Chahar Shamba, Maimanah.

10. TINNUNCULUS CENCHRIS, (Naum.).

1. Maruchak, Badghis, Herat, March 21.
2. Karawal Khana, Badghis, Herat, April 9.

These two specimens are alike; the wing coverts are mostly rufous, and there are a few small black spots on the abdomen and lower flanks. Wing 9 and 8·9 inches, tail 5·6 and 5·75, tarsus 1·23 and 1·25.

11. ASIO OTUS, (Linn.).

1. Kara Baba, Maimanah, March 10.

12. CARINE BACTRIANA, (Hutton).

1. Chahar Shamba, Maimanah, January 25.
2. Ditto ditto ditto, February 4.

13. MEROPS APIASTER, Linn.

1, 2, 3, 4 Chahar Shamba, Maimanah, April 29 to May 1.
5, Minar Shadian, Afghan Turkistan.

No. 5 is a young bird with the back green, but the throat coloured as in the adult.

14. CORACIAS GARRULA, Linn.

1, 2, 3 Chahar Shamba, Maimanah, April 30 and May 1.
4. Min Darakht, ditto, June 1.

15. CAPRIMULGUS EUROPÆUS, Linn.

1, 2, Kila Wali, Murghab, Herat, May 12.
3. Afghan Turkistan.

The pale eastern form separated as *C. unwini*. No. 3 has rufous bars on the wing where 1 and 2 have large white spots.

16. CYPSELUS APUS, (Linn.).

1. Karawal Khana, Badghis, Herat, April 12.
2. Ditto ditto ditto ditto, April 17.
3. Kila Wali, Murghab, Herat May 13.

17. CYPSELUS MELBA, (Linn.).

1. Murghab, Herat.

Wing 8·5 inches, tail 3·35.

18 UPUPA EPOPS, Linn.

1. Maimanah Chul, March 6.

19. LANIUS PHŒNICUROIDES, Severt.

1. Maruchak, Badghis, Herat, March 20.
2. Khwaja Gogirdak, Murghab, ditto, March 27.
3, 4, Darband-i-Kil Rekhta ditto ditto, May 18.
5. Maruchak, Badghis, ditto, May 18.

All these specimens fall under section B of the rufous-tailed shrikes as characterised by me in the Ibis, 1881, p 433. Nos. 3 and 4 are in full adult plumage, having the head very rufous, the bill, the whole lores, and the post-ocular stripe black, and the lower surface of the body white. Nos. 1, 2 and 5 are in immature plumage with bars on the breast, but the head is distinctly darker than the back. In all, the second primary is either intermediate in length to the fifth and sixth, or equals the sixth. In all stages this species seems to me readily distinguishable from *L. isabellinus*, Hempr. and Ehr.

20. ERYTHROSTERNA PARVA, (Bechst.).

1. ♀ Chahar Shamba, Maimanah, April 29.

21. PRATINCOLA CAPRATA, (Linn.).

1. ♂ Maruchak, Badghis, Herat, March 19.
2. ♂ Karawal Khana ditto ditto, April 9.
3. ♂ Ditto ditto ditto, April 19.
4. ♀ Kila Wali, Murghab ditto, May 13.

22. PRATINCOLA MAURA, (Pallas).

1, 2, Kara Baba, Maimanah, March 6.
3. Maruchak, Badghis, Herat, March 18.
4. Ditto ditto ditto, March 24.
5. Khwajeh Gogirdak, Murghab, ditto, March 27.
6. Karawal Khana, Badghis, ditto, April 9.

23. SYLVIA AFFINIS, Blyth.

1. Chahar Shamba, Maimanah, April 28.
2. Ditto ditto, May 1.

24. SYLVIA MINUSCULA, Hume.

1. Maruchak, Badghis, Herat, March 13.

25. SYLVIA MYSTACEA, Ménétr.

1. Kila Wali, Murghab, Herat, April 22.
2. Jalaiar, Maimanah, June 2.

This is the species well described and figured by Blanford in his 'Zoology of Eastern Persia' under the name of *Sylvia rubescens*. Its occurrence in the localities above cited is of much interest, as the distribution of the species is thereby considerably extended to both north and east of its previously known range.

26. SYLVIA FAMILIARIS, Ménétr.

1. Kila Wali, Murghab, Herat, April 22.
2. Darband-i-Kil Rekhta, ditto ditto, May 18.

27. HYPOLAIS PALLIDA, (Hemp and Ehr.).

1. Jalaiar, Maimanah, June 2.
2. Ditto.

28. HYPOLAIS RAMA, (Sykes.).

1. Kila Wali, Murghab, Herat, April 22.
2. Ditto ditto, May 13.
3. Darband-i-Kil Rekhta, ditto ditto, May 18.

29. ACROCEPHALUS STENTOREUS, (Hempr. and Ehr.).

1. 2. Kila Wali, Murghab, Herat, May 15.

30. CETTIA CETTI, (Marm.).

1. Chahar Shamba, Maimanah, February 20.
2. Ditto ditto, February 22.

31. MERULA VULGARIS, Selby.

1. ♂ Chahar Shamba, Maimanah, February 2.
2. ♀ Ditto ditto, February 12.

These examples belong to subspecies *M. maxima*, the male having the wing 5·6 inches and the female, 5·25.

32. MERULA ATRIGULARIS, (Temm.).

1. Chahar Shamba, Maimanah, January 25.
2, 3. Ditto ditto, January 28.
4. Ditto ditto, February 22.
5. Ditto ditto, April 4.

2 and 3 have the lores, chin, throat, and breast quite black.

33. CYANECULA SUECICA, (Linn.).

1.	Maruchak, Badghis, Herat,	March 18.
2.	Karawal Khana, ditto ditto,	March 24.
3.	Ditto ditto ditto,	April 9.
4.	Yedikul, Maimanah,	May 31.

34. MONTICOLA CYANUS, (Linn.).

1.	Darband-i-Kil Rekhta, Murghab Herat,	May 18.
2.	Shadian, Afghan Turkistan,	July 12.
3.	Ditto ditto,	Sept. 1.

Nos. 2 and 3 are in immature plumage.

35. RUTICILLA RUFIVENTRIS, (Vieill.).

1.	Deh Tang, Ghorband, Kabul,	October 8.

In female plumage.

36. RUTICILLA ERYTHRONOTA, (Eversm.).

1.	Chahar Shamba, Maimanah,	March 3.
2.	Andkhui,	March 20.

37. SAXICOLA MORIO, Hemp. and Ehr.

1.	Maruchak, Badghis, Herat,	March 18.
2.	Karawal Khana, ditto ditto,	April 9.
3.	Shadian, Afghan Turkistan,	July 9.

No. 3 is a nestling.

38. SAXICOLA OPISTHOLEUCA, Strickland.

1.	Maruchak, Badghis. Herat,	March 20.

39. SAXICOLA DESERTI, Temm..

1.	Maruchak, Murghat, Herat,	March 19.

An adult male, wing 3·55 inches, black on lateral rectrices 1·7; white edge on inner web of primaries not extending to shaft of feathers. Second primary intermediate in length to fifth and sixth.

40. SAXICOLA FINSCHII, Hengl.

1.	Kara Bala, Maimanah,	March 14.

41. SAXICOLA ISABELLINA, Rüpp.

1.	Chahar Shamba, Maimanah,	April 4.
2,	... ditto,	April 17.
3.	Khwaja Gogirdak,	

The black on the lateral tail feathers measures 0·95 inch.

42. Cinclus asiaticus, Bechst.

1. Iskar, Afghan Turkistan, Oct. 5.
2 & 3 Deh Tang, Ghorband, Kabul, Oct. 8.

No. 1 is a grey, spotted, young bird.

43. Hirundo rustica, Linn.

1. 2, Karawal Khana, Badghis, Herat, April 12.

44. Cotyle riparia, (Linn.).

1. Karawal Khana, Badghis, Herat, April 14.

45. Cotyle rupestris, (Scop.).

1. Darband-i-Kil Rokhta, Murghab, Herat, May 18.

46. Troglodytes parvulus, Koch.

1. Chahar Shamba, Maimanah, January 26.
2. Ditto ditto, January 28.
3. Ditto ditto, February 1.

Rather deeply coloured wrens, reddish brown above, the throat grey, and the general barring not so prominent as in *T. nipalensis*.

47. Sitta syriaca, Ehr.

1. 2. Darband-i-Kil Rekhta, Murghab, Herat, May 18.

The wings measure 3·45 and 3·4 inches, tail 2·15, tarsus ·1 and culmen 1 and 1·02.

48. Motacilla alba, Linn.

1. Maruchak, Badghis, Herat, December 15.
2. Chahar Shamba, Maimanah, March 3.
3. Ditto ditto, April 4.

49. Motacilla melanope, Pall.

1. Chahar Shamba, Maimanah, April 28.

50. Budytes melanocephala, (Licht.).

1. ♂ Khwaja Gogirdak, Murghab, Herat, Mar. 27.

This example is in full spring plumage.

51. Budytes citreola, (Pall.).

1, 2, Chahar Shamba, Maimanah, April 28.

52. ANTHUS BLAKISTONI, Swinhoe.

1. Chahar Shamba, Maimanah, February 3.
2. Ditto ditto, February 7.
3. Ditto ditto, February 8.
4, 5. Ditto ditto, February 22.

53. ANTHUS ROSACEUS, Hodgs.

1. Maruchak, Badghis, Herat, March 10.

In winter plumage.

54. ALAUDA GUTTATA, Brooks.

1. Kila Wali, Murghab, Herat.

Wing 3·6 inches, culmen 0·65, hind claw 0·5. Tertials 0·6 short of longest primary, breast finely streaked.

55. ALAUDA CRISTATA, Linn.

1. Chahar Shamba, Maimanah, January 4.
2. Ditto ditto, January 26.

The wings measure 4·5 and 4·0 inches, culmen 0·85 and 0·75.

56. CALANDRELLA BRACHYDACTYLA, (Leisl.).

1, 2 Maruchak, Badghis, Herat, March 17.
3. Khwajah Gogirdak, Murghab, ditto, March 27.

57. MELANOCORYPHA BIMACULATA, (Ménétr.).

1. 2, 3. Hauz-i-Khan, Murghab, Herat, Dec. 12.

58. CARDUELIS CANICEPS, (Vig.).

1. Andkhui, March

59. ERYTHROSPIZA OBSOLETA, (Licht.).

1, 2, Khwajah Gogirdak, Murghab, Herat, March 27.

Both examples have the bill black.

60. PASSER MONTANUS, Linn.

Chahar Shamba, Maimanah, January 29.

61. PASSER INDICUS, Jard and Selby.

1, 2, 3, 4. ♂ Karawal Khana. Murghab, Herat, April 15.

62. **PASSER HISPANIOLENSIS**, Temm.

1. Kara Bel, Maimanah, March 10.
2. Yulla Chashma, Murghab, Herat, March 10.
3, 4, Khwajah Gogirdak, ditto, ditto, March 27.
5. 6, Karawal Khana, ditto, ditto, April 12.

No. 5 is a young bird.

63. **EMBERIZA PYRRHULOIDES**, Pall.

1. ♂ Maimanah.
2. ♀ Chahar Shamba, ditto, February 1.

64. **EMBERIZA SCHÆNICLUS**, Linn.

1. ♀ Chahar Shamba, Maimanah, Feb. 20.
2, 3, ♂ Ditto ditto, March 3.
4, ♀ Kara Bel, ditto, March 10.
5, ♀ Gulla Chashma, Murghab (Herat) March 10.

65. **EMBERIZA FUCATA**, Pall.

1. Shadian, Afghan Turkistan, July 17.

In immature plumage with dark rufous patches appearing on breast. The feet are very pale and the claws pale horny.

66. **EUSPIZA LUTEOLA**, (Sparrm.).

1, 2, ♂ Chahar Shamba, Maimanah, April 28.
3, ♀ Ditto ditto, April 30.
4. ♀ Kila Wali, Murghab, Herat, May 12.
5. ♂ juv. ditto ditto, May 13.

67. **CORVUS FRUGILEGUS**, Linn.

1. Maruchak, Murghab, Herat, March 19.
2. Ditto ditto, March 23.

68. **CORVUS MONEDULA**, Linn.

1. Maruchak, Murghab, Herat, March 18.
2. Ditto ditto, March 21.
3. Karawal Khana, ditto, April 15.
4. Maruchak, ditto, Dec. 25.

69. **PICA RUSTICA**, (Scop.).

1. Chahar Shamba, Maimanah, February 3.
2. Ditto ditto, February 7.

70. **STURNUS VULGARIS**, (Linn.).

1. Chahar Shamba, February 11.

71. Sturnus poltaratskyi, Finsch.

1, 2 Chahar Shamba, Maimanah, February 11.
3. Ditto ditto, February 14.

72. Pastor roseus, (Linn.).

1, 2, Karawal Khana, Badghis, Herat, April 14.

73. Columba intermedia, Strickland.

1. Chahar Shamba, Maimanah, February 22.

74. Columba eversmanni, Bonap.

1. Min Darakht, Maimanah, June 1.

75. Turtur auritus, Gray.

1. Chilik, Afghan Turkistan, July 2.

76. Pterocles alchata, (Linn.).

1. 2 ♂ Kham-i-ab, Afghan Turkistan, June 18.
3. ♀ „ ditto

77. Phasianus principalis, Sclater.

1. ♂ Chahar Shamba, Maimanah, Feb. 10.
2. ♂ Maruchak, Murghab, Herat, March 10.
3. ♂ Ditto ditto, March 20.
4. ♀ Ditto ditto, March 26.
5. ♀ Ditto ditto, Dec. 25.

This fine pheasant has lately been described as new, from specimens obtained in the basin of the Murghab river by officers of the Afghan Boundary Commission. It is very like *Phasianus shawi* of Eastern Turkistan, but is fairly distinguishable from it by apparently constant characters. I have examined some half dozen males of this pheasant, and I note that the variation between individuals is very small; one, however (No 1) above has a distinct wash of green on the rump and upper tail coverts, and a small snow white spot on one side of the hind-neck, marking the position of a demi-collar. On the characters and distribution of *P. principalis*, *P. shawi*, and other allies of *P. colchicus*, Mr. Seebohm's interesting paper in the Ibis for April 1887, p. 168 may be consulted.

78. Tetraogallus himalayensis (Gray).

1. Dhap Darah, Hindu Kush, Turkistan, Oct. 7.

79. Cotunix communis, Bonn.
    1. ♂ Chahar Shamba, Maimanah, April 4.
    2. ♀ Karawal Khana, Murghab Herat, April 19.
    3. ♂ Chahar Shamba, Maimanah, May 6.

80. Ægialites curonica, Gmel.
    1, 2, Karawal Khana, Murghab, Herat, April 10.

81. Chettusia villotæi, (Audouin).
    1, 2, Kham-i-ab, Oxus, Afghan Turkistan, June 12.

82. Vanellus cristatus, Meyer.
    1. Chahar Shamba, Maimanah, Feb. 11.

83. Scolopax rusticula, (Linn.).
    1. Chahar Shamba, Maimanah, Feb. 3.

84. Gallinago solitaria, Hodgs.
    1. Deh Tang, Ghorband, Kabul, October 8.

85. Gallinago scolopacinus, Bonap.
    1. Chahar Shamba, Maimanah, February 5.

86. Machetes pugnax, (Linn.).
    1. ♂ Chahar Shamba, Maimanah, February 19.
    2. ☿ Ditto ditto April 4.

87. Totanus ochropus, (Linn.).
    1. Karawal Khana, Murghab, Herat, April 14.

88. Tringoides hypoleucus, (Linn.).
    1. Darband-i-Kol Rekhta, Murghab, Herat, May 18.
    2. Maruchak ditto ditto, May 22.

89. Himantopus candidus, Bonn.
    1. Oxus, Afghan Turkistan
    2. Kham-i-ab, ditto ditto, June 12.

90. Otis tetrax, Linn.
    1. Maruchak, Murghab, Herat, March 12.
    2. Chaman-i-Bed, Badghis, ditto Dec.

91. Rallus aquaticus, Linn.
    1. Maruchak, Murghab. Herat, Dec. 23.

92. **Porzana maruetta**, Leach.

1. Karawal Khana, Murghab, Herat, April 9.
2. Chahar Shamba, Maimanah, April 30.

93. **Porzana bailloni**, (Vieill.).

1, 2 Kila Wali, Murghab, Herat, April 24.

94. **Crex pratensis**, Bechst.

1. Maruchak, Murghab, Herat, May 7.

95. **Fulica atra**, Linn.

1. Andkhui, March

96. **Larus ridibundus**, Linn.

1. Maruchak, Murghab, Herat, March 18.

97. **Sterna anglica**, Mont.

1. Oxus, Afghan Turkistan.
2. Kham-i-ab, Oxus, Afghan Turkistan, June 12.

98. **Sterna minuta**, Linn.

1. Kham-i-ab, Afghan Turkistan, June 12.

99. **Phalacrocorax carbo**, (Linn.).

1. ♂ Maruchak, Badghis, Herat, March 19.

A fine example in full breeding plumage.

100. **Anas strepera**, Linn.

1. Karawal Khana, Murghab, Herat, April 16.

101. **Anas angustirostris** Ménétr.

1. Kham-i-ab, Oxus, Afghan Turkistan, June 12.

102. **Anas creeca**, Linn.

1. ♂ Chahar Shamba, Maimanah, Jan. 25.
2. ♀

103. **Anas penelope**, Linn.

1. ♂ Maruchak, Murghab, Herat, March 15.

104. **Fuligula cristata**, (Linn.).

1. Chahar Shamba, Maimanah, Feb. 20.

105. Fuligula nyroca, (Güld.).

1. ♂ 2 ♀	Kila Wali, Murghab, Herat,	March	5.
3. ♂	Maruchak, Badghis, ditto,	March	16.

106. Clangula glaucion, (Linn.).

1. ♀	Chahar Shamba, Maimanah	Feb.	12.
2.	Maruchak, Murghab, Herat,	March	15.
3. ♂	Ditto ditto,	March	20.

107. Erismatura leucocephala, Scop.

1. Maruchak, Afghan Turkistan, March 21.

108. Mergus albellus, (Linn.).

1. ♂ Adult,	Maimanah,	Feb.	10.
2. ♂ juv.	Chahar Shamba, Maimanah,	Feb.	12.
3. ♀	Ditto ditto,	Feb.	17.

No. 1 is in fine black and white plumage.

109. Tadorna vulpanser, Flem.

1. Oxus, Afghan Turkistan, Feb.

110. Casarca rutila, Pall.

1. Karawal Khana, Murghab, Herat, April 10.

VII.—*On the Species of* Loranthus *indigenous to Perak.*—*By* George King, M. B., LL. D., F. L. S., *Superintendent of the Royal Botanic Garden, Calcutta.*

[Received 29th March 1887;—Read 4th May 1887.]

Prior to the date of the punitive expedition which was despatched to Perak some years ago, that province was practically an unknown country. One of the results of the expedition just mentioned was the location in the state of a British Resident. And as the office of Resident has, fortunately for the interests of science and civilization, been held, almost from its first institution, by Sir Hugh Low, we are now in possession of the materials for obtaining some knowledge of its natural history. During the past few years considerable botanical collections have been accumulated by the Rev. Father Scortechini (now, alas! no more) who collected on behalf of the Perak Government, and by Mr. H. H. Kunstler, who collected for the Calcutta Botanic Garden. From the materials brought together by these gentlemen and which have come into my hands, I propose to draw up, as time permits, lists of species already described, together with descriptions of any which appear to be new. And I now begin the series by an enumeration of the species of *Loranthus* indigenous to the province.

The list which follows contains in all twenty-five species, of which eleven are described for the first time. At the end of the list I have appended descriptions of two new Sumatran species collected by Mr. H. O. Forbes. The genus being rather large and polymorphic, it has been divided into sections. In the following enumeration, I follow the sectional divisions adopted, in their *Genera Plantarum*, by Sir J. D. Hooker and and the late Mr. Bentham.

Section I. EULORANTHUS.

1. *L. Lobbii*, Hook. fil. Flora Brit. India, V, 204.

The commonest species in the province; growing on trees of various species, at elevations of from 500 to 4000 feet; found also in Penang and apparently also in Borneo. This species approaches very closely the Sumatran species *L. axanthus*, Korth.

Section II. PHŒNICANTHEMUM.

2. *L. pulcher*, DC. Prod. IV, 295: Hook. fil. Fl. Brit. Ind. V, 205; *L. speciosus*, Wall. Cat. 518; *L. coccineus*, Hook. Bot. Misc. t. 58; *Dendrophthoe pulcher*, Miq. Fl. Ind. Bat. I, pt. 1, 821.

Common; but scarcely ascending so high as the last. This varies greatly as to the breadth of its leaves which in some plants is as much as 3 inches, while in others it is barely 1 inch. Found also in Penang, and represented in Tenasserim by the closely allied species *L. Parishii*, Hook. fil., and in Java by *L. Lyndenianus*, Zoll.

3. *L. pentapetalus*, Roxb. Fl. Ind. I, 553, Ed. Carey and Wallich, II, 290.; Hook. fil. Fl. Brit. Ind. V. 206; DC. Prod. IV, 295; Wall. Pl. As. Rar. iii, t. 225, and Cat. 503; Kurz For. Flora Burmah, ii, 322; Griff. Notulae, IV, 617, and Ic. Pl. Asiat. t. 624, 625; Korth. Verhand, Loranth. 66; Blume Fl. Javae Loranth. 39, t. 14 and 23 A.; *Phœn. pentapetalum*, Miq. Fl. Ind. Bat. I, Pt. 1, p. 823: *Dendrophthoe pentapetala*, G. Don. Syst. iii, 419.

This is not very common in the province. It is a widely distributed species, being found in India from Nepal, along the outer and lower Himalaya, to Sikkim; thence through Assam, the Khasia Hills, Chittagong, to Burmah: it extends also to the Andamans, Penang, Malacca, Banka, Java, Sumatra, Borneo, and probably to other islands of the Malayan Archipelago. Sir J. D. Hooker reduces to this species *L polycarpus*, Wall. Cat. 540, and L. *erythrostachys*, Wall. MSS.

4. *L. coccineus*, Jack in Mal. Misc. I, 8; Hook. Bot. Misc. i, 278; Hook. fil. Fl. Brit. Ind. V, 206; Roxb. Fl. Ind. Ed. Carey and Wall. ii, 215; DC. Prod. IV, 296; Korth. Verhand. Loranth. 68; Griff. Notul. IV, 620, and Ic. Pl. Asiat. t. 626. *L. racemiferus*, Wall. Cat. 539; *Phœnicanthemum coccineum* and *Bennetianum*, Miq. Fl. Ind. Bat. I, pt. 1. 825, 826; *Dendrophthoe coccinea*, G. Don. Syst. iii, 419.

At low elevations: not common in the province: is found also in Pegu, Tavoy, Malacca, Singapore, and Penang, and extends to India (Cachar) and to some of the islands of the Malayan Archipelago.

Section III. HETERANTHUS.

5. *L. heteranthus*, Wall. Cat. 537; Hook. fil. Fl. Brit. Ind. V, 208; DC. Prod. V. 306; *L. eleutheropetalus*, Kurz in Journ. As. Soc. Beng. 1871, ii, 64, and For. Flora Burmah, ii, 321; *Dendrophthoe macrocalyx*, Miq. Fl. Ind. Bat. I. Pt. 1, 821.

Found in this province only in Laroot. This species extends as far northwards as Chittagong, where it was once collected by Mr. Lister. Wallich and Brandis found it in Burmah. Southward it extends to Java and Borneo.

6. *L. crassipetalus*, nov. spec. Glabrous in all its parts, except the bracteoles and calyx-tube which are puberulous; branchlets thick, striate, polished, the bark dark coloured; leaves coriaceous, rigid, petiolate, scattered, broadly ovate-oblong, rarely ovate-elliptic; apex obtuse; base attenuate; shining on the upper, dull on the lower, surface; nerves invisible when fresh, obscure when dry, midrib slightly prominent: length of blade 1·5 to 2 in. (in the ovate-elliptic leaves as much as 2·5 in.); breadth about 1 inch, rarely 1·5 in.; petiole ·25 in. long, stout; racemes longer than the leaves, stout, rigid, erect, axillary, sparsely many-flowered; pedicel thick, ·15 in. long, bearing at its apex a single broad, cochleate, bract, bracteole 0; calyx-tube cylindric, the limb wide-spreading, truncate, cup-shaped; corolla straight, narrowly conical, petals, 5, thick, distinct to their bases, smooth and yellowish externally, ridged and of a bright red internally, ·75 in. long; anthers linear, half as long as the petals, basifixed: style filiform, stigma minute.

Perak, on Gunong Idjou. Scortechini, Nos. 363 and 521.

7. *L. productus*, nov. spec. Quite glabrous; branches long, straight, strongly 4-angled, slightly flattened especially at the nodes, the bark polished and dark in colour; leaves coriaceous, petiolate, opposite, elliptic-lanceolate or ovate-oblong, gradually narrowed to the sub-acute or obtuse apex, narrowed rather suddenly to the petiole at the base; nerves obscure even when dry, midrib slightly prominent; length of blade 3·5 in. to 5 in.; breadth 1·5 in. to nearly 2 in.; petiole about ·5 in.

long; flowers crowded in small, sessile, axillary clusters; bract 0; bracteoles cohering into a short, cylindric, obscurely 2 to 4-crenate tube which, in the unfertilised flower, envelopes the whole of the calyx except its limb; calyx-tube shorter than the cylindric, truncate limb; petals 4, distinct, fleshy, linear, ·35 in. long, reflexed from about the middle; anthers linear, basifixed, nearly as long as the filaments, curved when mature; style shorter than the petals; stigma small, truncate; fruit ·3 in. in diameter, globular, smooth, crowned by the rather long cylindric calyx-limb and enveloped at its base by the persistent bracteolar cup.

Perak, at elevations of from 3000 to 3600 feet; Scortechini, Nos. 391 and 581; Kunstler (King's collector) No. 3240.

A remarkable species; with long, slender, polished branches which are almost black when dry. From the flower-bearing axils there often arise short, leaf-and-flower-bearing branches; and as the leaves on these (in herbarium specimens) usually fall off, they assume the appearance of long-peduncled cymes. This is clearly a *Heleranthus;* but it does not quite conform to the definition of that section given by Mr. Bentham and Sir J. D. Hooker in their *Gen. Plantar.* (iii, 208), inasmuch as there is no bract present, and there are bracteoles which form a cup almost entirely enveloping the calyx in the flower, and persisting even in the ripe fruit.

I have named this species from the length of its branches.

Section IV. CICLANTHUS.

8. *L. scurrula*, Linn. var. obtecta, Kurz For. Fl. Burm. ii, 319; Hook. fil. Fl. Brit. Ind. V, 209: *L. obtectus*, Wall. Cat. 534: *L. concavifolius*, Griff. Notul. IV, 615.

Very common at low elevations; Scortechini, Nos. 311*b*, 421*b*.

The typical form of this species occurs throughout the whole of British India; its other varieties, as defined in the Flora of British India, *viz.*, *bengalensis*, *laevigata*, and *graciliflora* having each a more circumscribed distribution.

9. *L. ferrugineus*, Roxb. Fl. Ind. I, 551, ii, 188; DC. Prod. IV, 299; Wall. Cat. 500; Hook. fil. Fl. Brit. Ind. V. 210; Jack in Mal. Misc. i, 9, and in Hook. Bot. Misc. i, 279, t. 59; *Dendrophthoe ferruginea*, G. Don Gen. Syst. iii, 420; Miq. Fl. Ind. Bat. I, Pt. 1, 812.

Not uncommon at low elevations; Scotechini, Nos. 630*b*, 2099.

Very common in Malacca, Singapore, and Penang: found also by Kurz in lower Burmah. Distributed also in Sumatra and Java. A specimen in the Calcutta Herbarium and named by him *L. Oortianus* Korth. is the same as this: and, if Junghuhn's identification is correct, Korthal's name, as being the older, must supplant Roxburgh's. *Dendrophthoe ignea*, Scheff. from Banka, according to the specimen in the Calcutta collection, is also the same as this. *L. Schultesii*, Bl., (Fl. Jav. Loranth, t. 2) appears to me referable to *L. scurrula*, Linn. rather than to this.

10. *L. Malaccensis*, Hook. fil. Fl. Brit. India, V, 210.

On high trees, at elevations of from 3000 to 4000 feet. King's Collector (Kunstler) No. 6286: found also at Malacca by Griffith.

Section V. DENDROPHTHOE.

11. *L. grandifrons*, nov. spec. Young branches rather thin, terete, little swollen at the nodes, the bark dark-coloured, lenticillate: leaves sub-opposite or alternate, rarely exactly opposite, coriaceous, petiolate, broadly ovate or ovate-oblong, the apex sub-acute, the base rounded or emarginate; main nerves 4 to 6 pairs, ascending, prominent (as is the midrib) especially on the lower surface; both surfaces dull, sparsely pulverulent; length of blade 5 to 8 inches, breadth 3 in. to 4·5 in.; petiole ·6 in. to 1 inch: the whole inflorescence covered with minute pulverulent, sub-deciduous, tomentum; racemes solitary, axillary, or from the older leafless branches, woody, erect, or slightly curved, 2·5 in. long, about 30-flowered, pedicels short; bract small, thick, clawed; calyx-tube cylindric, inflated at the base, the limb much longer than the short, sub-globose, ovary, 5 or 6 toothed; corolla-tube 3 inches long, cylindrical, 5 or 6-striate, slightly inflated towards the limb; lobes of limb ·5 in. long, reflexed, linear; anthers basifixed, linear, about half as long as the lobes; style filiform, a little longer than the stamens; stigma small, sub-globose.

In the low country, not very common. *Scortechini*, No. 926; Kunstler, Nos. 786 and 2067. Found also in the Lampongs, in Sumatra, on trees by the edge of heavy forest. H. O. Forbes, No. 1665.

When young the whole exterior of the corolla is tomentose like the calyx, but when fully expanded it occasionally becomes sub-glabrous. The base of the corolla is whitish; the upper part pink. In advanced bud some of the corollas are constricted at the apex and inflated towards the middle; but when fully expanded the corolla is tubular, gradually widening towards the mouth. This fine species comes near *pentandrus* as to technical characters: but in general appearance it somewhat resembles *L. longiflorus*, Desr. It is, however, well distinct from the latter by its differently shaped, more distinctly nerved leaves; and by its more erect, rigid, and scurfy inflorescence.

12. *L. pentandrus*, Linn. Mant. 63; Bl. Bijdr. 661; Hook. fil. Fl. Brit. Ind. V, 216; DC. Prod. IV, 305; Kurz For. Fl. Burmah, II, 320;

Wall. Cat. 514: Korth. Verhand. Loranth. 80; Blume Fl. Javae, Loranth. 33, t. 10: *L. farinosus*, Desr. in Lamk. Encycl. iii, 597; Roxb. Fl. Ind. Ed. Carey and Wall. ii, 221; Griff. Notul. IV, 616, and Ic. Pl. Asiat. t. 620, f. 1, 2; *Dendrophthoe pentandra* and *farinosa*, Miq. Fl. Ind. Bat. I; pt. 1, 818, 819; *Elytranthe farinosa*, G. Don. Gen. Syst. IV, 427.

Very common in all parts of the province at low elevations (Kunstler, Nos. 4931, 7538, 7767; Scortechini, No. 605); distributed northwards through Burmah and Chittagong as far as Sylhet, and southwards in the Malayan Peninsula and Archipelago generally. Sir J. D. Hooker reduces to this species *L. rigidus*, *contractus*, and *Finlaysonianus*, Wall. Cat. Nos. 531, 6864, and 6871.

13. *L. Scortechinii*, nov. spec. Glabrous, the young branches thick, terete, scarcely swollen at the nodes, the bark reddish; leaves coriaceous, petiolate, in verticels of about 6, oblong-lanceolate or oblong-elliptic, the apex shortly caudate-acuminate, the base attenuate; midrib prominent on both surfaces, nerves invisible in fresh, obscure in dry, specimens, about 15 pairs, sub-horizontal; length of blade 7 to 8 inches; breadth 2·25 to nearly 3 inches; petioles stout, 1·25 in.; racemes with a thick, pitted, woody axis little more than 1·5 in. long, axillary; flowers numerous, crowded; bract minute, cochleate, clawed; calyx tube cylindric, the limb irregularly dentate; corolla curved, tubular, slightly expanded upwards and 6-angled near its junction with the 6-cleft limb; lobes of limb linear, slightly expanded at the base, about a fifth of the length of the tube; anthers linear, obtuse, about half as long as the lobes; style as long as the stamens; stigma globose, small; corolla tube 4 in. long, limb 1 inch.

At elevations under 1000 feet, not common: Sortechini, No. 90*b*; Kunstler (King's collector), No. 6020.

This is a fine species, and is distinguished amongst Asiatic Dendropthoes by its large, verticillate leaves. The corolla is of a pale yellow, the lobes of the limb being tinged with green: the stigma is red.

14. *L. Duthieanus*, nov. spec. Young shoots terete, not swollen at the nodes, bark pale pinkish, sparsely lenticellate; axis of inflorescence and bracts minutely pubescent; other parts quite glabrous; leaves coriaceous, alternate opposite or in verticels of 3, petiolate, oblong-elliptic or elliptic-lanceolate with sub-acute apex and attenuate base, midrib and nerves invisible in the fresh, slightly visible in dry, specimens; length of blade 2·5 to 3 inches, breadth ·75 in. to 1 in., petiole ·4 in. long; racemes slender, axillary, shortly pedunculate, about 6-flowered; bract small, cochleate, clawed; bracteoles 0; calyx-tube cylindric, the limb, short, truncate, waved; corolla tubular, bright red in colour, curved, inflated upwards, constricted at the base and at the apex when in

bud, 6-striate, limb about one third of the length of the tube; the lobes 6, linear, sub-spathulate, thickened at the tips, reflexed; anther linear, about half as long as the lobes, basifixed; style filiform, as long as the stamens; stigma small, globular.

Collected only once by the late Father Scortechini, the exact locality being unknown.

A species allied to *curvatus*, Bl., but with a hexamerous, glabrous corolla, which is moreover wider and of a different colour from that of *curvatus;* also with narrower and more irregularly disposed leaves than in that species. Named after Mr. J. F. Duthie, Superintendent of the Botanic Garden, Saharunpore.

Section VI. LOXANTHERA.

15. *L. speciosus*, Bl. Fl. Jav. Loranth. 15, t. 20, and 23 fig. C. Miq. Fl. Ind. Bat. I, Pt. 822.; *L. coccineus*, Reinw. MSS. (not of Jack) Bl. Bijdr. 664; *L. Reinwardtianus*, Schult. Syst. DC. Prod. IV, 706: *L. loxantherus*, DC. l. c. p. 316.

Apparently not common in the Province; Scortechini, No. 1328; on the banks of the Kinta river (Kunstler, No. 767.) There is a single specimen in the Calcutta Herbarium from Malacca. The species is found in Sumatra (Forbes No. 3234*a*) and in Java.

Section VII. MACROSOLEN.

a. *longiflorae.*

16. *L. formosus*, Bl. Bijdr. 664 and Fl. Jav. Loranth. t. 15; DC. Prod. IV, 297; Kurz For. Flora Burmah ii, 317; Hook. fil. Fl. Brit. Ind. V, 220; *Macrosolen formosus*, Miq. Fl. Ind. Bat. I, Pt. 1, 827; *Elytranthe formosa*, G. Don Gen. Syst. iii, 426.

At elevations of from 3000 to 4000 feet, Kunstler, Nos. 2170 and 6264: found also in Java, and, according to a single leaf specimen in the Calcutta Herbarium (Griffith, No. 2729), also in Burmah.

17. *L. Kunstleri*, nov. spec. Quite glabrous; young branches stout, terete, the bark pale; leaves coriaceous, sub-sessile, opposite, ovate-oblong, gradually narrowed to the sub-acuminate apex, the base rounded, not cordate; midrib and nerves prominent on both surfaces (when dry) but especially on the lower; primary lateral nerves about 6 pairs, secondary about 8 pairs; length of blade 8 to 10 inches, breadth 3 in. to 4·5 in.; petiole very stout, about ·15 in. long; racemes very short, from the axils of the leaves and also from the old wood; bracteoles 3, minute, broad, united by their bases; calyx-tube cylindric, smooth, the limb truncate, slightly wavy; corolla clavate and boldly 6-angled in bud,

slightly curved, tubular, inflated at the base of the limb, lobes of the limb 6, reflexed, sub-spathulate, keeled externally, the tips thickened; anthers half as long as the lobes, linear, basifixed, with a slight process at the union with the filament; style filiform, as long as the stamens; stigma truncate; berry ·5 in. long, ovoid, bright yellow at first, black when ripe; length of corolla-tube 2·5 in., of limb ·6 in.

At elevations under 500 feet, H. H. Kunstler (King's collector), Nos. 2669, 2760, 6009, 8460.

This comes near *L. formosus*, Bl., but has much larger leaves, which have rounded (not acute) bases as in that species. The corolla also differs. Mr. Kunstler describes this as a very handsome species, the tube of the corolla being of a rich yellow, the limb bright green externally and dark red inside. It is a large species, plants of it often reaching 8 to 10 feet in length.

18. *L. dianthus*, King and Scort. MSS. Quite glabrous, the young shoots terete, thin, scarcely swollen at the nodes, the bark pale; leaves thinly coriaceous, entire, shortly petiolate, opposite, exactly lanceolate rarely ovate-lanceolate, the apex acuminate; midrib and primary nerves slightly visible when fresh, rather distinct when dry; length of blade 3 in. to 5 in., breadth ·75 in. to 2·5 in.; petioles slender, ·2 in. long; cymes axillary, sessile, 2-flowered; bracts at base of cyme 2, decussate, ovate-acute; bracteoles of the individual flowers united into a short, thick annulus which surrounds the base of the flower; calyx-tube smooth, cylindric, the limb short, truncate; corolla narrowly tubular, inflated and boldly 6-angled just under the limb, clavate in bud; limb with 6 twisted, reflexed, oblanceolate or sub-spathulate lobes which are keeled and inflated at the base; anthers basifixed, linear, one-third of the length of the lobes of the limb; style filiform, as long as the stamens; stigma small, capitate: fruit globular, smooth, ·5 in. in diam., crowned by the calyx-limb; length of corolla tube 2·5 in.; of limb ·75 in.

At elevations under 500 feet; Scortechini, Nos. 76 and 604*a*; King's Collector, Nos. 1870, 6446.

This species comes near *formosus*, Bl., from which the sessile, 2-flowered cymes, single, decussate pair of bracts, the annulus formed of the united bracteoles, and the globular berry are the best characters to distinguish it. This also must be near *L. meluitangensis*, Korth., of which I have seen no specimen. The tube of the corolla of this species is described as scarlet, and the lobes of the limb as green, with purple edges and a pale line along the anterior surface. The late Father Scortechini left a drawing of this species, to which I have added the details. He left no MSS. name for the species, but, from a note on the drawing, he appears to have considered it to be *L. formosus*, Bl. or near it.

19. *L. evenius*, Bl. Fl. Javae Loranth. t. 16; *L. avenis*, Bl. Bijdr. 663.; Korthals Verhand. Loranth. 85; DC. Prod. IV, 397; *Elytranthe avenis*, G. Don. Syst. iii, 426.

Found only once in Perak by Father Scortechini: extends also to Sumatra.

20. *L. platyphyllus*, nov. spec. Quite glabrous. Young branches 4-angled; leaves opposite or sub-opposite, thinly coriaceous, subsessile, broadly ovate-rotund or sub-orbicular, edges entire or unequally and remotely crenate, the apex obtuse, the base cordate; primary lateral nerves about 4 pairs, curving, somewhat distinct on both surfaces, the midrib rather prominent; length and breadth of blade about 4·5 in.; petiole less than ·15 in. long, stout; racemes very short, axillary, about 4-flowered; bract single, bracteoles minute, coalescing into a sinuate-edged cup less than a quarter of the length of the cylindrical, truncate, calyx-tube; corolla large, curved, tubular, expanding slightly upwards, 6-angled and inflated below the apex, clavate when in bud; limb 6-cleft, the lobes spreading, linear-lanceolate or sub-spathulate, blunt and inflexed at the tips, each with 2 ridges on the inner surface, inflated and keeled at the base; filaments adherent to the tube; anthers linear, basifixed; tube of corolla 3·5 in. long; limb ·8 in.; style filiform, as long as the stamens; stigma small, sub-capitate; fruit unknown.

Found only once by Scortechini, who has not noted the exact locality.

A species recognisable at once amongst the Asiatic species of *Macrosolen* by its large sub-sessile, nearly orbicular leaves.

b. *racemulosae.*

21. *L. ampullaceus*, Roxb. Fl. Ind. I, 552, ii, 189, and Ed. Carey and Wall. ii, 209; Hook. fil. Fl. Brit. Ind. V, 220; DC. Prod. IV, 296; Kurz For. Fl. Burm. ii, 316; Wall. Cat. 502. *L. sub-umbellatus*, Bl. Bijdr. 662 and Fl. Jav. Loranth. t. 18; *L. sphaerocarpus*, Bl. Bijdr. 661 and Fl. Jav. Loranth. t. 17; DC. Prod. IV, 297; *Macrosolen pallens*, *sphaerocarpus* and *oleioides*, Miq. Fl. Ind. Bat. i, Pt. 1, 830, 831; *Elytranthe sphæroidea*, Don. Gard. Dict. IV, 127.

On Ulu Bubong, at elevations from 500 to 1000 feet: Kunstler, Nos. 7866 and 10697. This species, as limited by Sir J. D. Hooker in his Flora of British India, is distributed from Bengal, Assam, and the Khasia Hills to Penang, Malacca, and Singapore. I agree with Hooker in considering it as probably a mere form of *L. globosus*, Roxb.; and, if this view be correct, the synonymy of *globosus* should be reduced here. The Wallichian species *pallens* (Cat. 523), *carinulatus* (529), *sub-globusus* (538), *oleifolius*, (524), *viridiflorus*, (512), are all forms of the same widely distributed and therefore variable plant.

22. *L. Lowii*, nov. spec. Glabrous everywhere, except the peduncles, pedicels, and bracteoles, which are puberulous; young shoots thin, terete, slightly swollen at the nodes, the bark pale brown; leaves rigid, coriaceous, ovate-lanceolate, or elliptic-lanceolate, gradually tapering to either end, the apex acute or acuminate, the edges recurved when dry; nerves invisible, midrib visible only on the pale, dull, under surface; length of blade 1·5 in. to 2 in.; breadth ·6 in., rarely ·8 inch.; petiole stout, ·15 in.; racemes umbellate, in clusters of 1 to 3, in the axils of the leaves, on short pedicels, 2 to 4-flowered; bract and bracteoles minute, broadly ovate, acute, the latter united by their bases into a 3-toothed cup: calyx tubular, smooth, the limb very short, truncate, waved; corolla about 1 in. long, the tube slightly curved, 6-angled and slightly inflated at the junction with the limb; lobes of the limb sub-spathulate, thickened at the apex, reflexed, about a third as long as the tube; anthers about a third as long as the lobes, linear; style filiform, nearly as long as the stamens; stigma small, sub-globular.

Found only once in the province (by Fr. Scortechini) and the exact locality not noted.

A species, in the texture of leaves and in inflorescence, approaching *L. retusus*, Jack; but very distinct from that and from the other Malayan species of *Macrosolen*. Named in honour of Sir Hugh Low, British Resident in Perak.

Section VIII. ELYTRANTHE.

23. *L. albidus*, Bl. Bijdr. 665, and Fl. Jav. Loranth. (sub *Elytranthe*) t. 22; Korth. Verhand. Loranth. 87; DC. Prod. IV, 299; Hook. fil. Fl. Brit. Ind. V, 222; *L. lecucosiphon*, Griff., Notul. IV, 623, and Ic. Pl. Asiat. t. 619-623: *Elytranthe albida*, Miq. Fl. Ind. Bat. I, Pt. 1, 832.

Not common; Scortechini, Nos. 428*b* and 626. This extends northwards to lower Burmah, and southwards to Malacca, Java, Sumatra, and Borneo.

Section IX. LEPIOSTEGERES.

24. *L. Beccarii*, nov. species. Glabrous; the younger branches quadrangular (at least when dry), the older branches terete; leaves on rather long petioles, opposite or sub-opposite, thinly coriaceous, entire, from ovate-lanceolate or ovate-oblong to sub-orbicular, very variable even on the same plant, the apex sub-acute or obtuse, the base cuneate or rounded, midrib prominent, especially on the under surface; primary nerves about 6 pairs, slightly visible on the under surface (when dry); length of blade 3·5 in. to 5 in., breadth 1·5 in. to nearly 3 in.; petiole ·75 in. to 1·25 in. long; capitula from the old wood, 20 to 30-flowered,

sessile, sub-globose when young, afterwards strobiliform and much elongate; the bracts large, numerous, imbricate, coloured, from oblong to semi-orbicular, obtuse, the inner 2 to 3 inches long, the outer gradually shorter, all empty; calyx short, cylindric, truncate; corolla, 3 to 3·5 in. long, the tube splitting into 6, very narrow, linear segments which are united for about ·5 in. at the base, and then again slightly just below the twisted, reflexed, linear, obtuse segments of the limb; anthers linear, pointed, basifixed, ·5 in. long: style filiform; stigma small, rounded, exserted slightly beyond the anthers; fruit sub-angular, globose, ·3 in. in diam.

Rare in the province; occurring at elevations under 2000 feet. Scortechini, 1208; King's Collector, Nos. 5793 and 7956. Found also in Borneo by Sig. Beccari (Herb. Becc. P. B. 1171).

This is the finest of all the Asiatic species of *Loranthus.* The enormous bracts are of a pale red colour; the tube of the corolla is of a deep claret purple, while the reflexed limb is yellow. The whole inflorescence is about 6 inches long and forms a most striking object.

25. *Loranthus Kingii,* Scortechini MSS. Young branches pale, terete, swollen at the nodes, slightly lenticillate when young, otherwise quite smooth; leaves coriaceous, petiolate, opposite, exactly ovate-lanceolate, smooth and with the nerves invisible on both surfaces, the midrib prominent below; length of blade 3 in.; breadth 1·25 in. to 1.5 in.; petiole about ·5 in.; capitula sessile, axillary, strobiliform, 4 to 6-flowered; bracts large, empty, coloured, keeled., in two series, an outer and an inner; the outer of 6 to 7 decussate pairs, the uppermost of which is linear-oblong, obtuse, 1·5 in. long, the lower pairs gradually smaller and more or less acute; the inner series of a single lanceolate pair; bracteoles round each individual flower 4, linear-lanceolate, about ·75 inch long; calyx very short, 6-toothed; corolla narrowly infundibuliform, curved below the middle, 1·75 in. long, split nearly half-way down on one side, and cleft at the apex for about one-fifth of its entire length into 5, lanceolate, acuminate, reflexed teeth; anthers basifixed, linear, subulate, with a slight process at their bases; style filiform, about as long as the stamens; stigma small, sub-capitate: fruit elongated ovoid, crowned by the remains of the calyx-tube.

Perak; Scortechini, No. 1251.

The late lamented Father Scortechini left only a single specimen of this with me. It appears, however, to agree with an imperfect specimen in the Calcutta Herbarium from Malacca (Herb. Maingay No. 695).

* * * * * *

I take the present opportunity of describing two new species collected by Mr. H. O. Forbes in Sumatra—both handsome plants, belonging respectively to the sections *Loxanthera* and *Lepiostegeres.*

Loranthus (Sect. *Loxanthera*) *Lampongus*, nov. spec. Branches terete, scurfy when young, as are the peduncles, ultimately all parts glabrous: leaves thickly coriaceous, opposite or sub-opposite, entire, petiolate, ovate-oblong to broadly ovate, apex sub-acute, or acute, base rounded, rarely sub-acute, the midrib very prominent and the nerves very indistinct on both surfaces, length of blade 4 to 5 inches: petioles stout, about ·75 in. long; flowers in pairs on crowded short, stout, bifurcate axillary peduncles; calyx tube short, cylindric, the limb truncate, irregularly and obscurely sinuate, sub-crenate; corolla nearly 1·5 in. long, clavate in bud, the cylindrical tube slightly inflated about the middle, cleft at the apex to about one third of its length into 6 linear-lanceolate lobes; stamens 6, the filament arcuate, dilated at the apex, and attached to the back of the linear anther below its middle; style filiform; stigma minute, clavate: bracteole short, broad, minute.

Lampongs, Sumatra: H. O. Forbes, No. 1737.

The curved filaments and dorsifixed anthers put this unmistakeably into the section *Loxanthera.* That section, however, as at present defined, is 5-merous. The definition of it must therefore be altered to 5 or 6-merous.

Loranthus (Sect. Lepiostegeres) *Forbesii*, nov. spec. Glabrous; the branches terete, with pale bark, swollen at the nodes; leaves coriaceous, petiolate, entire, opposite, ovate-oblong, sub-acute, the base rounded, or slightly cordate; midrib thick, prominent on the under surface; the nerves about 6 pairs, indistinct on both surfaces when fresh, slightly distinct on the upper surface when dry; length of blade 4·5 in. to 5·5 in.: breadth 2 in. to 2·5 in.; petiole stout, ·75 in. long; capitula 4 to 6-flowered, axillary, sessile, strobiliform, the bracts large, coloured, keeled, in two series, an outer and an inner; the outer series of 5 or 6 decussate pairs of which the upper pair are 2·3 in. long, the second pair about half as long, and the outer pairs gradually shorter, all obtuse; the inner series of 2 pairs, narrower than the outer, acuminate; each flower surrounded by 4 linear-lanceolate, keeled bracteoles about 1 inch in length; calyx tube very short, 6-toothed; corolla tubular, slightly widened above, the tube 6-angled, cleft for about one third of its entire length into 6, lanceolate, acuminate teeth: filaments flattened, grooved, adnate to the corolla-tube; anthers linear, subulate, with a process at their bases: style filiform, as long as the stamens; stigma small, cylindric.

Sumatra, near Kepala, at an elevation of 1200 feet. H. O. Ferbes, Herb. No. 2844.

Mr. Forbes found this superb species growing on a Leguminous tree. The bracts he describes as being scarlet, and the corolla of a brilliant lake colour.

VIII.—*E'tude sur les Arachnides de l' Asie méridionale faisant partie des collections de l' Indian Museum (Calcutta). Par* M. E. Simon, *de Paris.—Communicated by* The Superintendent of the Indian Museum.

[Received December 30th ;—Read June 1st, 1887.]

I.

Arachnides recueillis a Tavoy (Tennasserim) par Moti Ram.

Ordo ARANEÆ.

Fam. **Attidæ.**

1.—Plexippus culicivorus, Doleschall, *Tweede Bijdr.* etc., 1859, p. 14 pl. IX, f. 5. *(Attus)*.—

Menemerus culicivorus, Thorell, *Rag. Mal.* etc., I., p. 227 ; III, p. 508.

Egaya, Tavoy.

Répandu à Java, aux Célèbes, et à Amboine.

Fam. **Lycosidæ.**

Cette famille est représentée par deux espèces dont l' habitat est très étendu. *Hippasa greenalliæ* Blackw. est répandu dans toute l' Asie tropicale, dans l' Indoustan jusqu' à Ceylan, et dans l' Indo-Chine jusqu' à Malacca; nous l' avons indiqué nous-même de Birmanie, de Pondichéry, et de Wagra-Karoor dans le centre du Dekkan. *Ocyale atalanta* Sav. est encore plus remarquable par sa distribution : cette espèce, trouvée pour la première fois en Asie, est répandue dans toute l' Afrique tropicale du Sénégal à Mozambique et jusqu' à la Méditerranée par la vallée du Nil.

2.—Hippasa greenalliæ, Blackw, *Ann. Mag. Nat. Hist.* 1867 *(Lycosa)*.
Priata agelenoides E. Sim., *Ann. Mus. Civ. Gen.*, XX, 1884, p. 234.
Hippasa greenalliæ E. Sim., *Bull. Soc. Zool. Fr.*, 1885, p. 31.

Tavoy.

3.—Ocyale atalanta, Aud. in Sav., *E'g.* 1825-27, Ar. XXII, p. 149, pl. IV., f. 10.

Dolomedes ocyale, Walck., *Apt.*, I, 1837, p. 253.

Lycosa virulenta, Cambr., *P. Z. S. L.,* 1876, p. 600.

Ocyale atalanta, E. Sim., *Ann. Soc. ent. Fr.* 1885, p. 258.

Tavoy.

Fam. **Sparassidæ.**

4.—HETEROPODA VENATORIA, L.

Pour la synonymie cf. E. Sim., *Rév. Sparass.*, 1880, p. 48.

Tavoy.

5.—HETEROPODA LANGUIDA, *sp. nov.*

Ceph.-th. long. 10 *mm.*; lat. 8, 9 *mm.* Abd. long. 13 *mm.* Pedes I long. 36, 5 *mm.*; II 40 *mm.* III 33 *mm.*; IV 37, 5.

Cephalothorax evidenter longior quam latior crassus sat convexus laete rufo-castaneus cervino-pubescens, postice in declivitate testaceo-marginatus, stria thoracica longa. Oculi antici in apicibus lineam rectam formantes, medii lateralibus fere duplo minores inter se quam a lateralibus paulo remotiores sed spatio diametro oculi paulo angustiore sejuncti. Oculi postici in linea evidenter recurva, medii lateralibus saltem $\frac{1}{3}$ minores et a lateralibus quam inter se paulo remotiores. Medii aream non multo longiorem quam latiorem sed antice quam postice multo angustiorem occupantes, subaequales, antici vix minores. Clypeus subverticalis planus oculis lateralibus anticis latior. Sternum coxæ et laminæ rufo-castanea, pars labialis infuscata sed apice anguste testacea. Abdomen oblongum antice obtuse emarginatum fusco-lividum. Pedes mediocres sat robusti rufo-castanei, scopulæ sat densæ in metatarsis anticis basin attingentes sed in posticis partem apicalem tantum occupantes. Tibia IV cephalothoraci circiter aequilonga in parte secunda aculeo dorsali munita. Plaga vulvæ antice depressa foveolata et longitudinaliter carinata postice valde convexa semicirculari sed sulco angusto et profundo longitudinaliter secta.

Tavoy.

H. mediocri E. Sim. valde affinis, sed differt praesertim area oculorum mediorum breviore et sulco plagæ genitalis multo angustiore sublineari.

6.—HETEROPODA FERINA, *sp. nov.*

♂. Ceph.-th. long. 7, 6 *mm.* lat. 7, 2 *mm.* Pedes I 39, 4 *mm.*; II 43, 6 *mm.*; III 33, 6 *mm.*; IV 37 *mm.*

Cephalothorax vix longior quam latior parum convexus obscure fulvo-rufescens postice in declivitate et antice in clypeo testaceo-marginatus, supra lineis radiantibus obscurioribus notatus, stria thoracica longa. Oculi antici appropinquati in linea recta, medii lateralibus plus duplo minores et inter se quam a lateralibus remotiores spatio diametro oculi vix angustiore sejuncti. Oculi postici in linea evidenter recurva, medii lateralibus saltem $\frac{1}{3}$ minores et a lateralibus quam inter se remotiores. Medii aream longiorem quam latiorem et antice quam postice angustiorem occupantes, antici posticis minores. Clypeus oculis lateralibus anticis paulo angustior. Sternum fulvo-testaceum. Abdomen ovatum lurido-testaceum lurido-pubescens parcissime et inordinato fusco-punctatum et in parte apicali linea fusca transversim arcuata notatum, venter immaculatus. Pedes longi parum robusti fulvo-rufescentes femoribus dilutioribus sed supra levissime fusco-variatis. Scopulæ longæ parum densæ tarsos et metatarsorum extremitates tantum occupantes. Tibia IV cephalothorace multo longior aculeo dorsali in parte apicali sito munita. Pedes-maxillares fulvi tarso leviter infuscato, femore supra ad apicem 4—1 aculeato, patella paulo longiore quam latiore convexa utrinque uniaculeata, tibia patella longiore et graciliore prope basin aculeis longissimis quinque instructa apophysa apicali articulo multo breviore crassa antice directa nigra supra leviter rugosa et impressa ad apicem excisa, breviter emarginata et minute bimucronata (mucrone superiore altero longiore incurvo et acuto) infra in carinam obliquam producta, tarso angusto longissime producto in parte apicali teretiusculo, bulbo ovato simplici longitudinaliter sulcato.

Tavoy.

7.—PALYSTES KOCHI, E. Sim., *Rév. Sparass.*, 1880, p. 45.

Nous ne connaissions jusqu' ici que la femelle de cette espèce.

♂. Ceph.-th. long. 9 *mm.* Abd. long. 11 *mm.* Cephalothorax humilior quam in femina et paulo brevior quam tibia 4i paris, fusco-rufescens flavido-pubescens, linea media nigra exillima longitudinaliter sectus. Sternum coxæ oris partes venterque læte rufo-brunnea vel livida. Abdomen supra fulvo-cervinum. Chelarum margo inferior dentibus sat parvis quatuor 1o singulariter posito reliquis subcontiguis, 1o majore 2o et 4o minutissimis. Pedes multo longiores quam in femina fulvo-cervini femoribus infra rufulo-tinctis scopulis nigro-sericeis. Pedes-maxillares fulvi femore compresso leviter arcuato supra in parte apicali 4—1 aculeato, patella longiore quam latiore utrinque uniaculeata, tibia patella longiore terete prope basin et intus aculeis longissimis 4 vel 5 armata, extus apophysa apicali oblique divaricata sat valida valde uncata attenuata sed obtusa, tarso longe ovato supra cervino-piloso sed in parte apicali vitta fusca densius pilosa ornato, bulbo rufulo longe ovato apice depresso et processu membranaceo oblique munito.

Mita, Tavoy ; collines séparant la Birmanie de Siam.

Cette espèce a été découverte à Singapore.

8.—THELICTOPIS CANESCENS, *sp. nov.*

♀. Ceph.-th. long, 9 *mm.*; lat. 7, 4 *mm.* Abd. long. 12 *mm.*; lat. 7, 5 *mm.* Pedes I 24 *mm.*; II 23, 6 *mm.*; III 19 *mm.*; IV 24, 3 *mm.*

Cephalothorax niger laevis pilis albidis pronis, praesertim antice setis nigris mixtis, denso vestitus, crassus et convexus fronte lata, stria remota sat brevi sed profunda. Oculi antici in linea leviter procurva, medii lateralibus circiter $\frac{1}{3}$ majores a lateralibus quam inter se multo remotiores inter se spatio diametro oculi evidenter angustiore sejuncti. Oculi postici in linea levissime procurva, medii parvi spatio diametro oculi saltem quadruplo latiore sejuncti, laterales mediis paulo majores leviter prominuli. Area mediorum latior quam longior et antice quam postice angustior. Clypeus oculis mediis anticis haud vel non multo angustior. Chelæ robustissimæ ad basin valde geniculatæ nigro nitidæ parce setosæ. Partes oris sternum coxæque nigra. Abdomen sat late ovatum postice valde attenuatum et prope mammillas stria annulari profunde constrictum fuscum, fulvo-cinereo pubescens. Pedes breves et robusti femoribus atris reliquis articulis fusco-ravidis nigricanti-lineatis, tarsis dilutioribus, albo-cretaceo pubescentes et nigro-setosi. Tibia cum patella 4i paris cephalothorace paulo brevior. Tibiæ cunctæ aculeis dorsalibus carentes, quatuor anticæ aculeis inferioribus 5—5 sat brevibus munitæ sed lateralibus carentes, posticæ aculeis inferioribus 3—3 et utrinque lateralibus binæ munitæ. Patellæ muticæ. Scopulæ sat breves densæ basin metatarsorum sex anticorum attingentes sed apicem metarsorum posticorum tantum occupantes. Plaga vulvæ oblonga multo longior quam latior nigra rugosa et pilosa sulco medio lato rufulo et depresso longitudinaliter secta.

♂. Ceph.-th. long. 8 *mm*; lat. 7, 2 *mm*. Pedes I 27, 7 *mm*; II 28 *mm*.; III 23, 2 *mm*; IV 28, 7 *mm*.

Feminæ subsimilis sed cephalothorace paulo latiore, pedibus paulo longioribus, tibiis anticis aculeis inferioribus et utrinque aculeis lateralibus binis instructis, metatarsis anticis aculeo laterali subbasilari et tibiis cunctis aculeo dorsali submedio instructis. Pedes-maxillares obscure fusci breves et robusti, femore brevi supra in parte apicali 3—1 aculeato, patella paulo longiore quam latiore convexa aculeo interiore unico tantum armata, tibia patella breviore extus apophysis duabus longis subæquis et teretibus insigniter armata, tarso magno late ovato ad marginem exteriorem prope basin amplo dilatato, bulbo rufulo convexo valde complicato.

Collines séparant la Birmanie de Siam.

T. severæ L. Koch affinis differt imprimis oculis inter se distantioribus, plaga genitali longius ovata, etc.

Fam. **Epeiridæ.**

Les trois espèces qui représentent à Tavoy le groupe des *Gasteracanthinæ* existent également dans le Cambodge et la Cochinchine.

9.—Actinacantha propinqua, Cambr., *P. Z. S. L.*, 1879, p. 288, pl. XXVII., f. 16. *(Gasteracantha)*.

id. E. Sim., *Act. Soc. Linn. Bord.*, 1886.

Tavoy,—commun.

On peut ajouter à la description du Rev. O. P. Cambridge: Sternum nigrum dense et grosse nigro-granosum antice linea transversa sæpe in medio interrupta utrinque maculis binis subrotundis ad apicem macula elongata flavo-opacis lævibus decoratum. Pedum coxæ I et IV fulvæ ad basin fusco-notatæ, sed coxæ II et III omnino nigræ. Scutum ad marginem posticum punctis ocelliformibus decem (haud octo), sed punctis II et III conjunctis punctis mediis minutissimis. Longitudo spinarum valde variabilis.

10.—Gasteracantha frontata, Blackw., *A. M. N. H.*, ser. 3, vol. XIV, 1864, p. 40.

id. Cambr. *P. Z. S. L.* 1879, p. 283., pl. XXVI, f. 9.

id. E. Sim., *Act. Soc. Linn. Bord.* 1886.

Tavoy: Mita, Egaya (très commun).

Collines entre la Birmanie et Siam, etc.

11.—Gasteracantha annamita, E. Sim., *Act. Soc. Linn. Bord.* 1886.

Egaya. Tavoy.

12.—Epeira masoni, *sp. nov.*

♀. Ceph.-th. long. 9, 1; lat. 8, 3 *mm.* Abd. long. 14, 5; lat. 12, 5 *mm.* Pedes I long. 33, 4; II long. 32, 4; III 19, 5; IV 29 *mm.*

Cephalothorax niger parce et inaequaliter granulosus crasse et sat longe flavo-pilosus, parte cephalica lata subparallela sat convexa prope medium impressione transversa vix expressa notata postice striis obliquis angustis discreta. Oculi medii valde prominuli aream obliquam paulo longiorem quam latiorem et antice quam postice paulo latiorem occupantes, medii antici posticis plus duplo majores, spatium inter medios posticos diametro oculi paulo angustius. Oculi laterales a mediis latissime remoti prominuli haud tuberculati antici postico majores, spatio dimidio diametro oculi angustiore sejuncti. Oculi quatuor antici lineam leviter procurvam formantes sed in medio clypeo area ocularum paulo angustiore. Sternum nigrum immaculatum haud rugosum flavo-hirsutum. Chelæ nigræ sublaeves. Abdomen crassum et altum sed supra deplanatum obtusissime triquetrum, supra atrum longissime et crasse flavo-hirsutum immaculatum vel macula anteriore simplici aut duplici albo-opaca notatum. Venter niger pone plicam vitta transversa prope medium maculis transversis binis obscure testaceis ornatus. Pedes robusti et longi nigri vel obscure fusco-ravidi femoribus anticis infra cyaneo-tinctis, tibiis metatarsisque annulis sat angustis albo-cinereo pilosis ornatis, patellis tibiisque supra deplanatis et distincte bisulcatis, aculeis parum longis numerosis fulvo-rufulis ad radicem nigris. Vulvæ uncus sat longus subparallelus et obtusus supra marginatus prope basin leviter convexus parce rugosus et pilosus.

Tavoy.

Ep. de haani Dolesch. sat affinis differt imprimis area oculorum mediorum longiore, oculis mediis magis inaequalibus, lateralibus haud tuberculatis, abdominis angulis humeralibus obtusissimis, vulva haud foveolata unco longo et parallelo munita.

Pedes 4i paris ut in *E. de haani* paulo breviores quam anteriores.

13.—Epeira submucronata, *sp. nov.*

♀. Ceph.-th. long. 8, 5 ; lat. 6, 7 *mm.* Abd. long. 13, 2 ; lat. 11 *mm.* Pedes I long. 24 ; II 23, 2 ; III 14, 7 ; IV 24, 8 *mm.*

Cephalothorax ut in præcedenti sed densius granulosus et impressione cephalica majore et profundiore, obscure fusco-rufescens, parte cephalica breviter albido-pilosa thoracica utrinque longe et crebre flavo-hirsuta postice in declivitate glabra. Oculi medii valde prominuli aream subverticalem haud longiorem quam latiorem et antice quam postice non multo latiorem occupantes, medii antici posticis evidenter majores, spatium inter posticos diametrum oculi fere æquans. Oculi laterales a mediis longissime remoti sub tuberculo infulo conico et divaricato impositi subaequales et spatio dimidio diametro oculi angustiore sejuncti. Oculi quatuor antici lineam evidenter procurvam formantes. Clypeus in medio area oculorum latior. Sternum obscure fuscum immaculatum flavo-pilosum grosse parce et inordinate granulosum. Chelæ fulvo-rufescentes apicem versus sensim obscuriores. Abdomen crassum et altum sed supra deplanatum triquetrum angulis humeralibus acute productis angulo apicali tuberculis tribus contiguis uniseriatis medio reliquis majore instructo, supra fulvo-cervinum parce setosum et brevissime fulvo-nitido pubescens, antice in declivitate fusco-piceum lineis transversis exillimis albo-pilosis transversim sectum linea prima inter tubercula humeralia ducta integra aliis (2 vel 3) in medio late interruptis. Venter obscure fuscus utrinque fulvo-marginatus pone plicam vitta transversa prope medium macula magna subquadrata obscure fulvis ornatus. Pedes robusti et sat longi obscure fulvoravidi, femoribus anticis infra cyaneo-tinctis, fulvo-pubescentes metatarsis anticis annulo medio exili tibiis metatarsisque posticis annulo basilari lato albido-pilosis ornatis, patellis tibiisque supra deplanatis et distincte bisulcatis, aculeis numerosis parum longis testaceo-pellucentibus. Vulva antice fovea subquadrata postice tuberculo mediocri semicirculari piloso apice breviter et acute uncato munita.

Var. (♀ junior). Cephalothorax fulvo-rufescens impressionibus cephalicis fuscis. Abdomen fulvo-cervinum linea media longitudinali

et utrinque lineis transversis fuscis notatum. Pedes fulvi femoribus infuscatis tibiis metatarsisque posticis fusco-annulatis.

Tavoy. Egaya.

Ep. de haani et *E. caput-lupi* Dolesch. valde affinis, differt praesertim oculis lateralibus longius tuberculatis, apice abdominali trituberculato, etc.

Vulva fere ut in *Ep. de haani.*

Pedes 4i paris ut in *Ep. caput-lupi* longiores quam pedes quatuor anteriores.

14.—CÆROSTRIS PARADOXA, Dolesch., *Tweede Bijdr. Kenn. Arachn. Ind. Ar.*, 1859, p. 37, pl. IX, f. 11. et pl. X, f. 8. *(Epeira).*

Mintas et Mita, Tavoy.

Espèce répandue en Malaisie et dans l' Indo-Chine.

15.—NEPHILA MACULATA, Fabr., *Ent. Syst.*, II, 1793, p. 425 *(Aranea).*

N. fuscipes, C. Koch, *Ar.*, VI, 1839, p. 136, f. 528.

(Pour la synonymie cf. Thorell, *Rag. Mal.* etc. III, p. 145).

Tavoy; Mita, Tavoy.

Répandu dans toute l'Asie méridionale, la Malaisie, les Philippines, et l' Australie septentrionale.

16.—NEPHILENGYS MALABARENSIS, Walck., *Apt.* II, 1841, p. 103 (*Epeira*).

Epeira anama, Walck., *l. c.*, p. 103.

Epeira rhodosternon, Dolesch., *Tweede Bijdr.* etc. 1859, p. 40.

Nephila rivulata, Cambr., *P. Z. S. L.*, 1871, p. 517, pl. XLIX, f. 1-2.

Nephilengys hofmanni, L. Koch, *Ar. Austr.*, 1872, p. 145; pl. XI, f. 8.

Nephilengys malabarensis, Thorell, Simon, etc.

Egaya, Tavoy.

Espèce répandue dans presque toutes les régions chaudes du globe: en Afrique, en Australie, et en Amérique; indiqué de Siam par Thorell et par nous-même.

17.—META FASTIGIATA, E. Sim., *Ann. Soc. ent. Fr.* 1877, p. 79.

Meta fastuosa, Thorell, *Rag. Mal.* etc., I, 1877, p. 413.

Meta fastigiata, E. Sim., *Act. Soc. Linn. Bord.*, 1886.

Tavoy; Mintas, Tavoy.

Répandue aux Philippines, aux Célèbes, et à Siam.

Fam. **Pholcidæ.**

18.—PHOLCUS ELONGATUS, Vinson, *Ar. Réun.* etc. 1864, p. 135, pl. III, f. 5.

P. phalangioides, Dolesch., *Tweede Bijdr.* etc. 1859, p. 47.

P. tipuloides, L. Koch, *Ar. Austr.*, 1872, p. 281, pl. XXIII, f. 5.

P. distinctus, Cambr., J. L. S. Z., X, 1876, p. 380, pl. XI, f. 28-30.

P. margarita, Workman, *A. & M. N. H.* 5th ser. t. II, 1878, p. 451, pl. XVIII. f. 1-2.

P. elongatus, V. Hasselt, *Tijdr. v. Ent.*, XX, 1877, p. 53.

id. Thorell, *Rag. Mal.* etc. II, 1878, p. 162.

Egaya. Tavoy.

Répandu dans presque toutes les régions chaudes, probablement importé.

Fam. **Drassidæ**.

Subfam. *Ctenini.*

19.—LEPTOCTENUS TUMIDULUS, *sp. nov.*

♂ (*pullus*). long. 15 *mm.* Cephalothorax ovatus antice parum attenuatus fronte lata postice valde convexus et stria profunda sectus, obscure fulvo-ravidus fulvo-pubescens, parte cephalica utrinque lineolis fuscis obliquis parte thoracica linea marginali et vittis dorsalibus latis pallide fuscis dentatis et lineis radiantibus obscurioribus sectis notatis. Oculi fere ut in *L. denticulato* sed area mediorum latius transversa et oculis lateralibus seriei 2æ a mediis latius remotis. Clypeus oculis anticis haud latior retro obliquus. Abdomen sat late ovatum fusco-testaceum fulvo et albido-pubescens parce et inordinate fusco-punctatum in parte anteriore punctis majoribus biseriatim ordinatis notatum. Mammillæ inferiores fuscæ, superiores flavæ. Sternum fusco-rufescens albido-setosum. Chelæ subnigræ nitidæ subtilissime vix conspicue transversim rugatæ, margine inferiore sulci quadridentato dentibus 1 et 2 reliquis paulo majoribus. Pedes sat breves et robusti fulvo-ravidi confuse olivaceo-annulati. Tibiæ anticæ infra 5—5 aculeatæ (aculeis 3i paris reliquis longioribus) metatarsis aculeis similibus 3—3. Tibiæ posticæ aculeis lateralibus inferioribus atque aculeis dorsalibus 3 uniseriatis instructæ. Patellæ posticæ utrinque uniaculeatæ. Tibia cum patella IV cephalothoraci fere æquilonga. Tarsi cuncti metatarsique quatuor anteriores breviter et sat dense scopulati.

Tavoy.

L. denticulato E. Sim. affinis, differt imprimis cephalothorace postice convexiore, pedibus brevioribus, etc.

Fam. **Avicularidæ.**

Sect. 1. *Trionichi.*

Genus ATMETOCHILUS *nov.*

Cephalothorax ovatus plus ¼ longior quam latior pubescens parte cephalica lata modice convexa, fovea procurva semicirculari profunda, parte thoracica humili postice attenuata et truncata. Area oculorum compactilis circiter triplo latior quam longior utrinque subparallela (oculorum series postica paulo angustior quam antica). Oculi quatuor antici maximi subaequales fere aeque et sat auguste separati (intervalla dimidio diametro oculi vix latiora) in linea modice procurva. Oculi postici subaequales anticis multo minores utrinque approximati. Oculus lateralis posticus antico fere duplo minor et ab antico spatio diametro oculi paulo angustiore sejunctus. Chelæ robustæ supra visæ sat breves intus ad apicem leviter convexæ, rastello ex dentibus numerosissimis inordinatis iniquis et parum robustis composito. Pars labialis paulo longior quam latior leviter attenuata et obtusa immobili a sterno stria superficiali vix expressa discreta mutica. Coxæ pedum-maxillarium ad basin denticulis paucis armatæ. Sternum ovatum antice attenuatum impressionibus magnis confluentibus antice foveam magnam transversim semicircularem formantibus. Pedes robusti sat longi, metatarsi quatuor anteriores tibiis circiter aequilongi, metatarsi postici tibiis multo longiores. Tarsi metatarsique quatuor anteriores et tarsi pedum-maxillarium scopulis parum densis setis intermixtis vestiti, tarsi postici infra dense setosi. Metatarsi antici aculeis paucis instructi. Ungues tarsorum cunctorum dentibus paucis basilaribus ad marginem exteriorem muniti et ungues tarsorum anticorum dente minutissimo submedio ad marginem interiorem tantum armati. Mammillæ superiores articulo basilari crasso et sat longo, medio breviore, apicali medio longiore basilari fere æquilongo angustiore recto et attenuato.

Gen. *Cystauchenio* Th. sat vicinum differt oculis anticis magnis æquis et parum disjunctis, sterno late foveolato, parte labiali ad basin vix discreta, metatarsis anticis pluriaculeatis, mammillarum articulo ultimo longiore et acuminato, structura ungium tarsalium, etc.

20.—ATMETOCHILUS FOSSOR, *sp. nov.*

♀. Ceph.-th. long. 20; lat. 14, 2 *mm.* Abd. long. 22, 5; lat. 16, 5 *mm.* Pedes I 44, 6; II 40, 5; III 34, 7; IV 48, 8 *mm.*

Cephalothorax sublævis sed opacus læte fusco-rufescens pilis longis pronis sericeis setis nigris mixtis parum dense vestitus. Oculi quatuor antici maximi subæquales, medii rotundi, laterales ovati et obliqui, medii a lateralibus quam inter se vix remotiores spatio dimidio diametro oculi evidenter angustiore sejuncti, medii postici subrotundi levissime angulosi, laterales late ovati mediis vix majores et lateralibus anticis multo minores. Chelæ nigræ sublæves valde et inæqualiter crinitæ. Abdomen convexum late ovatum atro-sericeum tenuiter et parce setosum in lateribus inordinate testaceo-striolatum infra obscure fulvum. Mammillæ fulvæ. Sternum læte fusco-rufescens postice dilutius læve. Pedes-maxillares pedesque subnigri coxis femoribusque infra dilutioribus et rufulis, patellis tibiisque supra vittis duabus latis glabris et rufulis ornatis. Tibiæ anticæ infra aculeis apicalibus binis et aculeis exterioribus uniseriatis 3, metatarsi aculeis apicalibus binis et exterioribus binis armati. Tibiæ posticæ parce metatarsi numerose aculeati.

Tavoy.

Sect. II. *Dionichi.*

21.—? Phrictus flavopilosus, E. Sim., *Ann. Mus. Civ. Gen.*, XX, 1884, p. 358.

Tavoy.

Je rapporte avec doute à cette espèce quelques jeunes individus en mauvais état.

P. flavopilosus a été découvert en Birmanie.

Genus Cyriopagopus *nov.*

Gen. *Selenocosmiæ* affine. Cephalothorax oblongus multo humilior subplanus fovea sublineari leviter procurva (haud semilunari). Tuber oculorum parum convexum magnum saltem duplo latius quam longius a margine antico spatio diametro oculi lateralis antici latiore sejunctum. Oculi antici in linea parum procurva (margo anticus mediorum ante centrum lateralium situs) subæquales fere æquidistantes spatiis diametro oculi evidenter angustioribus sejuncti. Medii postici multo minores quam medii antici et laterales postici late ovati recti. Laterales postici anticis minores atque ab anticis spatio diametro minore oculi haud latiore sejuncti. Pedes parum longi robustissimi extremitates versus parum attenuati omnino mutici. Patella cum tibia IV evidenter longior quam patella cum tibia I. Scopulæ densissimæ, in metatarsis sex anterioribus basin articuli attingentes, in metatarso 4i paris partem apicalem tantum occupantes. Scopulæ tarsorum cunctorum et metatarsorum sex anticorum integræ sed scopulæ metatarsi postici linea setosa anguste sectæ. Cætera ut in *Selenocosmia.*

Gen. *Phrycto* sat affine imprimis differt scopulis tarsorum integris et linea oculorum anticorum magis procurva.

22.—CYRIOPAGOPUS PAGANUS, *sp. nov.*

♀. Ceph.-th. long. 14 *mm*; lat. 11, 5 *mm*. Abd. long. 21 *mm*. Pedes-max. long. 21 *mm*. Pedes I 39 *mm*; II 36 *mm*; III 32, 2 *mm*; IV 43, 6 *mm*.

Cephalothorax humilis subplanus obscure fusco-rufescens sat longe et adpresse fulvo-cervino-pubescens. Area oculorum magna transversa. Oculi quatuor antici subæquales, medii rotundi, laterales longe ovati æquidistantes et spatiis diametro oculi paulo angustioribus separati. Medii postici late ovati subrecti, laterales postici longe ovati mediis duplo majores sed lateralibus anticis minores. Abdomen oblongum nigricans ferrugineo-pubescens et longe setosum. Pars labialis subplana haud striata nec depressa in parte apicali minute et crebre spinulosa. Chelæ sternum pedes-maxillares pedesque nigella ferrugineo-hirsuta, tibiis metatarsisque supra ad apicem pilis albidis paucis angustissime cinctis. Pedes breves et robustissimi. Tibia cum patella I breviores quam iidem articuli IV (circiter ex $\frac{1}{3}$ patellæ). Metatarsus IV tibia haud vel vix longior.

Tavoy. Egaya.

Ordo PEDIPALPI.

23.—THELYPHONUS FORMOSUS, Butler, *Ann. Mag. Nat. Hist.* 1872, p. 203, pl. XIII, f. 4.

La forme remarquable de la patte-mâchoire indiquée dans cette espèce par Butler (*l. c.* f. 4) est un caractère sexuel propre au mâle. Chez la femelle la patte-mâchoire est de forme normale et se rapproche beaucoup de celle de *T. assamensis*, Stol.; le trochanter offre également cinq dents au bord supérieur.

Les deux espèces different par les caractères suivants :—

In *T. formoso* trochanteris dentibus acutioribus tribus interioribus subsimilibus (in *assamensi* dente basali obsoleto) pedum-maxillarium articulis cunctis supra omnino lævibus (in *assamensi* trochantere et femore parce granosis) oculis mediis minoribus spatio subplano diametro oculi saltem haud angustiore sejunctis (in *assamensi* spatio angustiore et convexo), tarsi pedum Ii paris articulis cunctis muticis I et II subæquis III—VII brevioribus et inter se subæquis ultimo tereti recto præcedentibus duobus simul sumptis haud longiore (in *assamensi* articulis IV, V, VI, et VII intus ad apicem breviter dentatis et articulo V reliquis longiore).

Tavoy.

Déjà indiqué de Tennasserim par Butler.

Ordo SCORPIONES.

24.—ISOMETRUS VARIUS, C. Koch, 1845.

Tityus varius, C. Koch, *Ar.* XI, p. 29, f. 864.

Isometrus varius, E. Sim., *Ann. Mus. civ. Gen.*, XX, 1884, p. 363.

Tavoy.

Nous l' avons déjà indiqué de Birmanie. Il est en outre très répandu en Indo-Chine, à Siam et à Saïgon, et en Malaisie, à Sumatra et à Java.

25.—PALAMNÆUS BENGALENSIS, C. Koch, 1842.

Buthus bengalensis, C. Koch, *Ar.* IX, p. 3, f. 696.

Palamnœus bengalensis, E. Sim., *Ann. Mus. Civ. Gen.*, XX, 1884, p. 360.

Tavoy.

Très répandu en Birmanie.

26.—SCORPIOPS ANTHRACINUS, *sp. nov.*

Long. trunci 25, 5 *mm.* Caudæ 22, 5 *mm.*

Nigro-opacus corpore subtus coxis tarsisque dilutioribus et rufescentibus. Cephalothorax segmentis caudæ I, II, et III anterioribus simul sumptis non multo brevior, supra fere planus subparallelus antice parum attenuatus, ad marginem anticum profundissime et obtuse excisus et utrinque in lobum attenuatum et obtuse truncatum productus, supra granulis grossis inæqualibus inordinate conspersus, ante tuber oculorum sulco lato profundo carinis granulosis limitato impressus postice sulco longitudinali angustiore et sulco transverso recto sed utrinque antice flexuoso munitus. Tuber oculorum longe ante medium situm ovatum læve subtiliter sulcatum spatio inter oculos diametro oculi haud latiore seu paulo angustiore. Oculi laterales sub carina granulosa siti in linea recurva I et II æquales tertio minor. Segmenta abdominalia supra grosse dense et inordinate granulosa, segmenta III—VI antice leviter impressa et carina media longitudinali debili notata, segmentum VII parcius granulosum et carinis granulosis binis subrectis munitum. Segmenta ventralia lævia nitida sed ultimum subtiliter coriaceum et in parte apicali carinis quatuor debilibus sublævibus instructum. Cauda sat debilis minute et parce granulosa, segmenta I—IV carinis octo inferioribus sublævibus superioribus dentatis, carinæ dorsales in segmento II, et imprimis in segmentis III et IV alte cristatis et dente apicali fortiore instructæ. Segmentum Vm segmenta III et IV simul sumptis longitudine æquans, carinis septem minute et regulariter dentatis munitum. Vesica longe ovata segmento caudæ Vo vix brevior subtiliter coriacea et infra prope basin minute et parce granulosa, aculeo vesica multo breviore. Pedes-maxillares longi et parum robusti femore et

tibia deplanatis et supra et infra carinis dense granulosis munitis supra parce granulosis infra sublævibus, tibia intus dentibus validis æquis binis subbasilaribus instructa infra prope marginem exteriorem punctis impressis piliferis XIX uniseriatis munita, manu tibia non multo latiore sed multo longiore parallela subtiliter granulosa subangulosa et costis granulosis latis munita digiti mobili manu postica paulo longiore. Dent. pect. 10—11.

Tavoy.

A *S. Hardwicki* Gerv. et *solido* Karsch differt manu angusta et carinis dorsalibus segmentorum caudæ dente apicali reliquis dentibus multo validiore; *S. montano* Karsch valde affinis sed differt imprimis cephalothorace grosse granuloso, digito mobili pedum-maxillarium manu longiore, dentibus pectinum 10—11, etc.

27.—Liocheles australasiæ, Fabr., *Syst. Ent.*, 1775, p. 399.

Ischnurus australasiæ, E. Koch, *Ar.* IV, p. 71, f. 294.

Ischnurus pistaceus, E. Sim., *Ann. Soc. Ent. Fr.* 1876.

Hormurus australasiæ, Thorell, *E'tud. Scorpiol.*, 1877, p. 177.

Tavoy.

Très répandu dans la Polynesie, la Malaisie, les Philippines, la Cochinchine, etc.

A *L. complanato* C. Koch differt cephalothorace impresse punctato in medio subtiliter rugoso haud granuloso, segmentis caudæ I et præsertim II et V infra valde dentatis, etc. A *L. neocaledonico*, E. Sim. differt cephalothorace haud granuloso, caudæ segmento V infra dentato, manu impresse punctata et granulis humilibus ornata, etc.

Le genre *Liocheles* Sundevall (*Conspectus Arachnidum*, 1833, p. 31) correspond au genre *Hormurus* Thorell, comme l' a démontré le Dr. Karsch (*Zeitschrift. f. ges. Naturwissenschft.* 1880, t. LIII, p. 480).

Ordo OPILIONES.

Sub-ordo *OP. MECOSTETHI.*

28.—Maracandus reticulatus, *sp. nov.*

♂. Long. 5, 8 *mm*; Lat. 4, 3 *mm.*

Scutum dorsale paulo longius quam latius antice obtuse truncatum postice sensim ampliatum et recte sectum supra fere planum vix convexum haud striatum nec impressum subtiliter coriaceum haud granulosum fulvo-olivaceum confuse fusco-reticulatum et transversim lineatum ad marginem anticum tuberculo medio minuto et utrinque (supra radicem pedum-maxillarium) tuberculis albis binis longis et teretibus munitum, in regione abdominali tuberculis nigris sex in series duas parallelas ordinatis (anticis quatuor minutissimis granuliformibus ultimis longis erectis et acutis) instructum. Tuber oculorum maximum ovato-transversum haud sulcatum supra tuberculis parvis et obtusis biseriatis (2-2 vel 3-3) notatum. Abdominis segmenta posteriora libera et ventralia brunnea mutica sed serie granulorum minutissimorum munita. Coxæ fulvæ confuse fusco-atomariæ, posticae ad marginem posteriorem pone spiraculum tuberculis crenulatis paucis munitæ reliquæ coxæ utrinque obtuse serratæ et anticæ serie media grossius granulosa ornatæ. Chelæ modicæ fulvæ læves nitidæ articulo basali convexo subgloboso. Pedes-maxillares fulvi plus minus fusco-variati corpore breviores, femore compresso infra tuberculis parvis obtusis et inæqualibus uniseriatis munito atque intus ad apicem tuberculo paulo longiore et acuto instructo, patella saltem triplo longiore quam latiore basin versus longe attenuata supra leviter convexa infra plana, ad marginem interiorem fere mutica ad exteriorem tuberculis parvis et obtusis 4-5 munita, tibia patella saltem ¼ breviore subparallela infra plana ad marginem interiorem aculeo subapicali acuto diametro articulo breviore ad exteriorem aculeis similibus binis instructa, tarso tibia breviore sat lato ovato valde attenuato utrinque aculeis binis sat parvis munito, ungue gracili tarso haud breviore. Pedes fulvo-olivacei plus minus fusco-retriculati et sublineati sat longi et valde inæquales antici reliquis multo breviores cuncti cylindracei et mutici, tarsus I 9-articulati, tarsi II 19, tarsi III 11, tarsi IV 13-articulati. Ungues mutici.

♀. Long. 8 *mm*, lat. 5, 2 *mm*.

A mare differt corpore crassiore et convexiore brunneo-rufescenti leviter et parce fulvo-variato, tuberculo frontali erecto multo longiore et tuberculis obtusis binis apicalibus oculorum tuberis validioribus, regione abdominali tuberculis quatuor ad basin crassis granulosis et nigris ad apicem acutis et albidis anticis posticis minoribus, pedibus-maxillaribus brevioribus tuberculo femorali interiori minutissimo aculeis tibiæ et tarsi brevioribus, pedibus multo brevioribus fusco-rufescentibus apicem versus sensim dilutioribus, tarso I 8, tarso II 13—14, tarso III 9, tarso IV 10-articulatis.

Tavoy.

Nous ne rapportons qu' avec doute cette espèce au genre *Maracandus ;* elle diffère en effet des espèces types* par le scutum dorsal sans stries transverses, le tubercule oculaire non déprimé, enfin par les stigmates bien visibles—caractère exceptionnel dans la famille des *Phalangodidæ*.

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* *M. macei* E. Sim. du Bengale et *M. mouhoti* E. Sim. du Cambodge, cf. *Ann. Soc. ent. Belg.*, 1880.

Sub-ordo *OP. PLAGIOSTETHI.*

Genus GAGRELLA, Stoliczka.

Ce genre est représenté dans la région de Tavoy par les espèces suivantes.

Conspectus specierum.

1.—Tuber oculorum omnino læve et muticum longitudinaliter sulcatum, corpus nigrum scuto abdominali vittis flavis quatuor ornato,.......................... *quadrivittata.*

Tuber oculorum tuberculis parvis æquis biseriatim ordinatis instructum,.................................. 2

2.—Corpus fulvum, scuto abdominali vittata fusca confusa notato, infra omnino sublæve,.................... *cervina.*

Corpus nigrum postice flavo-bimaculatum, infra subtiliter coriaceum et in processu sternali parce granosum,.. *binotata.*

29.—GAGRELLA CERVINA, *sp. nov.*

Long. 6—8 *mm.*

Corpus brevissime ovatum valde convexum crebre et sat tenuiter coriaceo-rugosum fulvo-cervinum, parte thoracica dilutiore et flavida sed utrinque impressione obliqua infuscata notata, scuto abdominali in parte prima vitta media lata fusca confusa notato, tubere oculorum saltem supra et spina abdominali nigris. Pars thoracica ad marginem mutica. Tuber oculorum altum supra visum subrotundum et tuberculis parvis æquis in series duas antice divaricatas parum regulariter ordinatis instructum, intervallo oculorum diametrum oculi circiter æquanti. Spina abdominalis longa verticalis acuta usque ad basin sat gracilis parce rugosa. Corpus infra sublæve pallide flavo-testaceum, coxis minute et parcissime granulosis sed utrinque crebre nigro-serratis. Chelæ et pedes-maxillares omnino pallide flavi. Chelæ læves muticæ. Pedes-maxillares femore infra patella supra minutissime et inordinate spinulosis, tibia patella haud longiore parallela. Pedes longissimi cylindracei fusco-rufescentes trochanteribus nigricantibus femoribus patellisque sat remote tibiis remotissime et minutissime spinulosis.

Mita, Tavoy.

30.—GAGRELLA BINOTATA, *sp. nov.*

Long. 8 *mm.*

Corpus breviter ovatum convexum omnino crebre et valde coriaceo-rugosum, nigerrimum, parte thoracica ante tuber lineis binis exilibus et utrinque supra foramen margine tenui obscure rufulis parum distinctis notata, scuto abdominali antice utrinque spatio magno obscure rufulo et postice maculis binis transversis lævibus læte flavis ornato. Pars thoracica ad marginem mutica. Tuber oculorum sat altum supra visum subrotundum tuberculis parvis æquis biseriatim ordinatis munitum, intervallo oculorum diametro oculi non multo latiore. Spina abdominalis verticalis mediocris acuta usque ad basin sat gracilis parce granosa. Segmenta abdominalia infra subtilissime coriacea et in medio granulis minutissimis paucis munita fusca ad marginem posticum et utrinque dilutiora et rufescentia, processu sternali fusco sat remote granuloso. Coxæ nigricantes densius granulosæ utrinque serratæ. Chelæ læves muticæ nigræ, digitis dilutioribus. Pedes-maxillares nigri, femore infra patella tibiaque intus minutissime et sat crebre spinulosis, tibia patella vix longiore angustiore et parallela. Pedes longissimi cylindracei nigri tarsis leviter dilutioribus femoribus minute et sat remote spinulosis.

Tavoy.

31.—Gagrella quadravittata, *sp. nov.*

Long. 8, 5 *mm.*

Corpus breviter ovatum convexum in medio prope spinam abdominalem grosse et crebre granosum antice posticeque sensim lævius, nigerrimum, parte thoracica ante tuber vitta media flava prope marginem linea nigra exili secta postice secundum tuber crasse bifurcata, pone tuber utrinque maculis binis transversis, scuto abdominali vittis flavis quatuor integris dorsalibus duabus antice ampliatis et utrinque marginali angustiore apicem haud attingente. Pars thoracica ad marginem mutica. Tuber oculorum sat humile supra visum paulo latius quam longius omnino læve et muticum sed sulco longitudinali divisum, intervallo oculorum diametro oculi multo latiore. Spina abdominalis mediocris ad basin crassa et valde granulosa ad apicem subacuta. Corpus infra sublæve obscure testaceum segmentis transversim fusco-vittatis et processu sternali infuscato. Coxæ fuscæ præsertim anticæ sat denso granulosæ utrinque crebre serratæ. Chelæ læves muticæ nigræ digitis dilutioribus. Pedes-maxillares obscure fusci femore infra patella tibiaque intus minutissime et inordinate spinulosis, tibia patella vix longiore angustiore et parallela, tarso longissimo compresso apicem versus leviter et sensim incrassato. Pedes longissimi cylindracei fusco-rufescentes trochanteribus femoribusque basin versus nigricantibus femoribus minutissime (vix perspicue) et remotissime spinulosis.

Tavoy.

G. signatæ Stol. sat affinis differt corpore in parte granuloso (in *G. signata* omnino granulosa) et scuto abdominali flavo quadrivittato (in *G. signata* tantum flavo-marginato).

IX.—*On the Differential Equation of a Trajectory.*—*By* Asutosh Mukhopadhyay, M. A., F. R. A. S., F. R. S. E. *Communicated by* The Hon'ble Mahendralal Sarkar, M. D., C. I. E.

[Received April 28th ;—Read May 4th, 1887.]

§ 1. The problem of determining the oblique trajectory of a system of confocal ellipses, appears to have been first solved by the Italian Mathematician Mainardi, in a memoir in the *Annali di Scienze Mathematische e Fisiche*, t. I, page 251, which has been reproduced by Boole (*Differential Equations*, 4th edition, pp. 248-251). Representing half the distance between the foci by h, and the tangent of the angle of intersection by n, we obtain for the equation of the trajectory,

$$-2n\tan^{-1}\sqrt{\left(\frac{h^2}{xM}-1\right)}+\log\frac{1-\sqrt{1-\frac{M}{x}}}{1+\sqrt{1-\frac{M}{x}}}=C\ \ldots\ldots\ldots\ldots\ (1)$$

where C is the constant of integration, and M is given by the quadratic

$$(x^2+y^2+h^2)M=x\,(M^2+h^2)\ldots\ldots\ldots\ldots\ (2)$$

Now, this form of the equation is so complicated that it would be a hopeless task to have to trace the curve from it; indeed, it is so unsymmetrical and inelegant that Professor Forsyth in his splendid work on Differential Equations (page 131) does not at all give the answer. In the present note, the curve is represented by a pair of remarkably simple equations which admit of an interesting geometrical interpretation.

§ 2. Assume then

$$xM=h^2\cos^2\phi$$
$$C=2n\lambda$$

where λ is a new constant. Substituting in (1), we have

$$\log\frac{1-\sqrt{1-\frac{M}{x}}}{1+\sqrt{1-\frac{M}{x}}}=2n\lambda+2n\phi.$$

$$\therefore \quad \frac{1-\sqrt{1-\frac{M}{x}}}{1+\sqrt{1-\frac{M}{x}}}=e^{2n(\lambda+\phi)}$$

$$\frac{1}{\sqrt{1-\frac{M}{x}}}=\frac{1+e^{2n(\lambda+\phi)}}{1-e^{2n(\lambda+\phi)}}$$

$$\therefore\ 1-\frac{M}{x}=\left\{\frac{1-e^{2n(\lambda+\phi)}}{1+e^{2n(\lambda+\phi)}}\right\}^2$$

$$\therefore\ \frac{M}{x}=1-\left(\frac{1-e^{2n(\lambda+\phi)}}{1+e^{2n(\lambda+\phi)}}\right)^2=\frac{4e^{2n(\lambda+\phi)}}{\left\{1+e^{2n(\lambda+\phi)}\right\}^2}$$

But, $$M=\frac{h^2}{x}\cos^2\phi$$

$\therefore$ Substituting in the above and extracting the square root, we get

$$\frac{h}{x}\cos\phi=\frac{2e^{n(\lambda+\phi)}}{1+e^{2n(\lambda+\phi)}}$$

$$\therefore\ x=h\cos\phi\,\frac{1+e^{2n(\lambda+\phi)}}{2e^{n(\lambda+\phi)}}$$

$$=h\cos\phi\,\tfrac{1}{2}\left\{e^{n(\lambda+\phi)}+e^{-n(\lambda+\phi)}\right\}$$

$$=h\cos\phi.\ \cosh n(\lambda+\phi).$$

Again, substituting the value of M in (2), we have

$$(x^2+y^2+h^2)\frac{h^2\cos^2\phi}{x}=x\left(\frac{h^4\cos^4\phi}{x^2}+h^2\right)$$

$$\therefore\ x^2+y^2+h^2=h^2\cos^2\phi+x^2\sec^2\phi$$

$$\therefore\ y^2+h^2\sin^2\phi=x^2\tan^2\phi$$

$$\therefore\ \frac{x^2}{h^2\cos^2\phi}-\frac{y^2}{h^2\sin^2\phi}=1,$$

and, since we have shown that

$$x=h\cos\phi.\ \cosh n(\lambda+\phi),$$

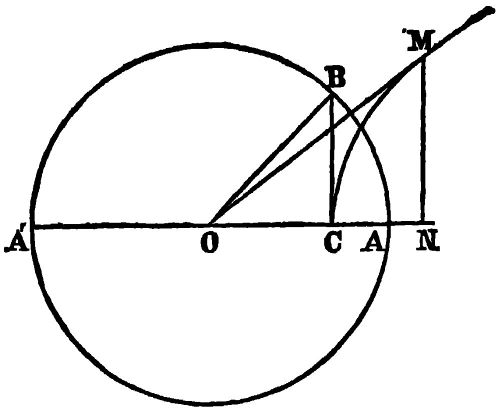
we see at once that

$$y=h\sin\phi\ .\ \sinh n(\lambda+\phi).$$

Therefore, the co-ordinates of any point on the trajectory may be expressed in a very neat and symmetrical form, in terms of a parameter ϕ *viz.*, we have

$$\left.\begin{aligned} x &= h \cos\phi . \cosh n(\lambda+\phi). \\ y &= h \sin\phi . \sinh n(\lambda+\phi). \end{aligned}\right\} \ldots\ldots\ldots\ldots (A).$$

§ 3. The equations (A) admit of a very simple geometrical interpretation.



Let A′A be the line joining the foci of the system of confocal ellipses, so that OA $= h$. On A′A as diameter, describe a circle having its centre at O. Draw any radius OB, making the angle AOB $= \phi$; draw BC perpendicular to OA; then, we have OC $= h \cos\phi$, BC $= h \sin\phi$. Construct a hyperbola CM, having its centre at O, and its transverse and congugate axes equal to OC, BC respectively; then, of course, BC is a tangent and OB an asymptote to this hyperbola. Take a point M on the hyperbola, so that the area of the hyperbolic sector OCM may be $n(\lambda+\phi)$ times the area of the triangle OCB: then, I assert that M is a point on the trajectory, *viz.*, the co-ordinates of M are

$$x = h \cos\phi . \cosh n(\lambda+\phi).$$
$$y = h \sin\phi . \sinh n(\lambda+\phi).$$

To see how this is, drop MN perpendicular on OA. Then, writing for the moment OC $= h \cos\phi = a$, BC $= h \sin\phi = \beta$, the hyperbola is

$$\frac{x^2}{a^2} - \frac{y^2}{\beta^2} = 1$$

and, any point (x_1, y_1) as M on this hyperbola is obviously satisfied by $x_1 = a \cosh\psi$, $y_1 = \beta \sinh\psi$. Now, the area of the portion CMN is given by

$$\text{CMN} = \int_a^{x_1} y dx = \frac{\beta}{a}\int_a^{x_1} \sqrt{x^2 - a^2}\, dx$$

$$= \frac{\beta}{2a}\left\{ x\sqrt{x^2-a^2} - a^2 \log\left(x + \sqrt{x^2-a^2}\right) \right\}_{x=a}^{x=x_1}$$

$$= \frac{\beta}{2a}\left\{ a^2 \cosh\psi \sinh\psi - a^2 \log\frac{a\cosh\psi + a\sinh\psi}{a} \right\}$$

$$[\because x_1 = a\cosh\psi]$$

$$= \frac{\beta}{2a}\left\{ a^2 \cosh\psi \sinh\psi - a^2\psi \right\}$$

$$= \tfrac{1}{2}\,\alpha\beta \cosh\psi \sinh\psi - \tfrac{1}{2}\,\alpha\beta\psi$$
$$= \tfrac{1}{2}\,\text{ON}.\,\text{NM} - \tfrac{1}{2}\,\alpha\beta\psi = \text{ONM} - \tfrac{1}{2}\alpha\beta\psi$$
$$\therefore\ \text{OCM} = \tfrac{1}{2}\alpha\beta\psi = \text{OCB}.\ \psi.$$

But, *ex hypothesi*, $\text{OCM} = \text{OCB}.\ n(\lambda+\phi)$

$$\therefore\ \psi = n(\lambda+\phi),$$

which shews that the co-ordinates of M are given by

$$x_1 = \alpha\cosh\psi = h\cos\phi.\ \cosh n(\lambda+\phi)$$
$$y_1 = \beta\sinh\psi = h\sin\phi.\ \sinh n(\lambda+\phi),$$

and, therefore, M is a point on the trajectory. We thus see that not only are the co-ordinates of M expressible in a very simple form, but also that the position of M can be determined geometrically, corresponding to any position of B on the circle; hence, the curve can be completely traced. It is easy to remark that whatever may be the value of the arbitrary constant λ, the point M lies on the hyperbola CM, for a given value of ϕ. Finally, a geometrical relation is worth noticing, *viz.*, since the circular sector $\text{AOB} = \tfrac{1}{2}h^2\phi$, we have from

$$\text{OCM} = n(\lambda+\phi)\ \text{OBC},$$

the equation

$$\text{OCM} = n\lambda\ \text{OBC} + 2n\,\frac{\text{OAB}.\ \text{OBC}}{h^2}$$

or,

$$\text{OCM} = n\lambda\ \text{OBC} + 2n\,\frac{\text{OAB}}{\text{OA}}.\ \frac{\text{OBC}}{\text{OB}}.$$

S. R. ELSON, Journ Asiat. Soc Bengal, 1887, Vol. LVI, Pt II. Pl. IX.

Fig 1.

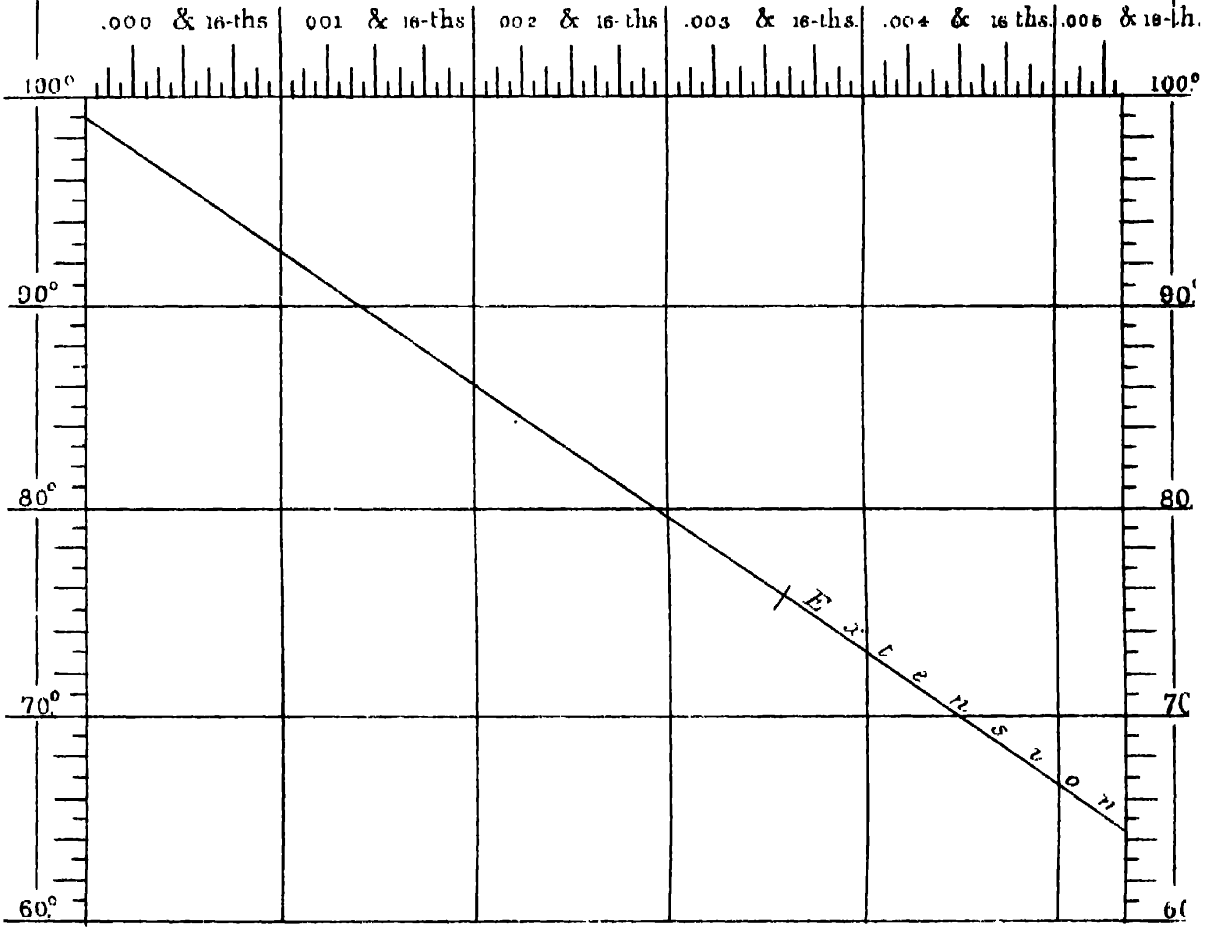
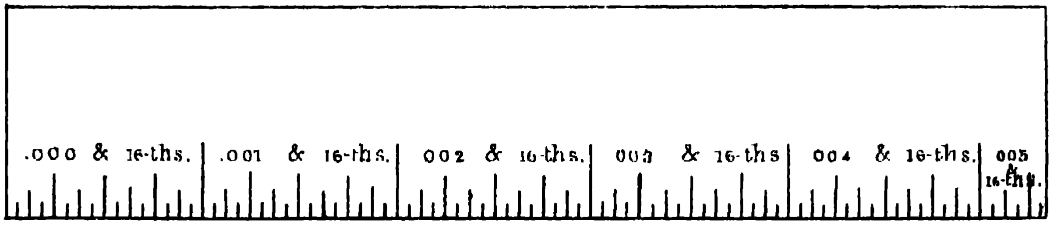


Fig. 2



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JOURNAL

OF THE

ASIATIC SOCIETY OF BENGAL.

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Part II.—NATURAL SCIENCE.

No. II.—1887.

X.—*On the Effects produced by Small Quantities of Bismuth on the Ductility of Silver.*—*By* Surgeon-Major J. Scully, *Assay Master, Calcutta.*

[Received June 13th ;—Read July 6th, 1887.]

It is well known that alloys of silver and bismuth, in certain proportions, are brittle. In Dr. Percy's valuable work on Metallurgy (Silver and Gold—Part I), it is stated that alloys of silver with bismuth, in the proportion of 50 per cent. and 33 per cent. of the latter metal, are brittle; while an ore of silver and bismuth, called Chilenite, in which bismuth occurs only to the extent of 14·4 to 15·3 per cent., is said to be malleable. The least amount of bismuth, however, which will injuriously affect the ductility of silver, for example, in such an operation as the lamination of silver bars for coinage, does not, so far as I am aware, appear to have been experimentally investigated. It may here be mentioned at the outset that an alloy of silver and bismuth may, by careful hammering, be extended considerably, so as to pass muster as malleable; although, if subjected to lamination by means of steel rolls, the same alloy will crack at the edges and thus show a deficient ductility, as compared with pure silver or some silver-copper alloys. It is to the deficiency in ductility, as tested by rolling, of silver containing only very small proportions of bismuth that I here wish to call attention.

My attention was first prominently directed, about two years ago, to the injurious effects caused by small quantities of bismuth in silver by the circumstance that some silver bullion, in the shape of English refined bars of as high a fineness as 990 per mille, proved so brittle as to be unfit for mintage. Attention was first attracted to this matter by the peculiar behaviour under assay of the granulated samples taken from this silver after melting. The appearances noticed under assay will be referred to presently, but they led to the bullion being at once tested for brittleness. A bar, about 21 inches long, 2·25 broad, and 1 inch thick, was hammered out at one end without cracking, but on being passed through the rolls it cracked badly at the edges and was pronounced to be "brittle," in the Mint sense of the term. The bullion was then remelted in five plumbago pots, and a partial refinement of it attempted in the ordinary way with nitre, about eight to ten pounds of this salt being used for each pot. The resulting silver bars were not appreciably improved by this treatment; hammering again proved an inconclusive test, but a bar of the size I have mentioned broke in two by merely dropping on the floor of the melting room.

In the meantime the assay had shown that the brittle bullion contained bismuth, and that this was the only substance present likely to be the cause of brittleness. The Indian process of assaying silver has been described by Dr. Busteed in the Journal of the Asiatic Society of Bengal (1870, Part II. p. 377); and a brief abstract of this paper is given on p. 292 of Dr. Percy's work before mentioned. The main features of the process may here be briefly recapitulated for the purpose I have in view. A fixed weight of the silver bullion to be assayed is dissolved in an assay bottle, by means of nitric acid aided by heat; the solution is diluted with water and an *excess* of hydrochloric acid is added, to precipitate all the silver present as chloride. The silver chloride having been caused to aggregate and settle by vigorous shaking, the bottle is filled up with water and the supernatant fluid is subsequently syphoned off, to remove all the now dissolved matter which may have been contained in the bullion. Under these conditions of solution, precipitation and dilution with water, chemists will readily understand that even a small trace of bismuth, if it be in the silver, will reveal its presence by the partial formation of insoluble oxychloride of bismuth. Now, in the assay of the brittle bullion under consideration, solution in nitric acid had been readily and completely effected by the aid of heat: antimony and tin were consequently absent. After the addition of water and hydrochloric acid, however, the solution in the assay bottles could not be cleared by shaking; the bulk of the silver chloride collected at the bottom of the bottles, but the supernatant fluid remained turbid. Tin and antimony being excluded, only two metals could produce this result in the wet assay of silver, namely, mercury and bismuth. To determine which of these is the interfering metal it is only necessary to note the effect of solar light on the silver chloride formed; when mercury is present the silver chloride maintains its pure white colour unaltered, while in the presence of bismuth the chloride immediately acquires the well known purple colour under the influence of daylight. Our assays, then, being turbid after precipitation and yet the silver chloride blackening readily under the influence of daylight, it was evident that bismuth was present. The turbidity produced was due to the partial formation of bismuth oxychloride; and this compound diffusing itself in its characteristic manner through the solution had broken up part of the silver salt into very fine powder, so that some hours had to elapse before the supernatant fluid cleared by the gradual subsidence of both bismuth oxychloride and the finely divided silver chloride. The assay was of course thus rendered unreliable, since the silver chloride to be weighed, and on which the calculation of the fineness rested, was contaminated with bismuth oxychloride. A cupellation assay of this bullion was at once had recourse to for ascertaining its fineness.

So far, then, this tender of silver bullion seemed to establish the following points:—

1. Silver bullion of as high fineness as 990 per mille is rendered unfit for coinage purposes by an amount of bismuth which, in this particular case, could not possibly have exceeded 1 *per cent.*, and was probably less than that proportion.

2. Hammering a bar of silver bullion is not a good test for detecting brittleness, as far as mint purposes are concerned.

3. The toughening of silver bullion 990 fine, and containing only a small amount of bismuth, by the aid of nitre in plumbago melting pots, is not readily effected.

4. The presence of a trace of bismuth in silver of high fineness is immediately detected in the ordinary course of assay by the Indian method, but this bismuth interferes with the perfect accuracy of the results obtained by that process.

A comprehensive research seemed therefore called for to elucidate the whole subject, and the necessity for this investigation has since been emphasized by the fact that silver bullion contaminated with bismuth has frequently found its way to the Mint since its first discovery here. The points to be investigated seemed naturally to group themselves under the following heads:—

I. Is our ordinary wet assay of silver susceptible of such easy modification as will enable us to obtain perfectly accurate results by it, in presence of bismuth, without having recourse to the confessedly less accurate assay by cupellation? And, how may small quantities of bismuth in silver be readily estimated with the despatch indispensable for mint operations?

II. What is the smallest amount of bismuth in silver that will render it unfit for coinage, when present in bars of the Indian standard fineness of 916·6? And, what is the amount of bismuth that may be tolerated in such bars without materially injuring their ductility?

III. How is silver bullion containing bismuth which may be tendered to the Mint, to be dealt with, supposing that establishment accepts any metal that is brittle; and how is the presence of bismuth in refined bars to be accounted for?

I. As the purity of the bismuth to be used in the experiments now to be detailed was a matter of first importance, I may briefly mention the steps taken to ensure the purity of the metal. Refined bismuth was dissolved in nitric acid, precipitated as basic nitrate by diluting largely with distilled water, the nitrate digested in solution of caustic potash, and then well washed, dried, and reduced by heating with charcoal in a clay crucible. A series of synthetical assays, made by dissolving together pure silver and pure bismuth, the latter in the proportion of from 1 to 5 millièmes, showed that our ordinary process of assay, under such conditions, gave unreliable results, there being a surcharge, or higher report than should have been obtained, which varied from 0·7 to 2·7 mill. when the proportion of bismuth was from 3 to 5 millièmes. A modification in our process of assay was evidently required if it were to be used for determining the fineness of silver bullion containing bismuth; and the necessary steps to this end were, after repeated experiment, found to consist in adding the smallest possible amount of hydrochloric acid for the precipitation of the silver, and increasing the amount of nitric acid in which it was first dissolved. We use ordinarily for the precipitation of an assay pound of silver 5·4 cc. of hydrochloric acid of sp. gr. 1075, but 2·5 cc. of acid of this strength suffices for the complete precipitation of an assay pound of even fine silver; so that we have here at once a means of diminishing the tendency of any bismuth in the silver to form insoluble oxychloride. If in addition to diminishing the amount of hydrochloric acid we added a considerable excess of nitric acid to the solution (which acid would not in any way interfere with the silver chloride formed), all risk of the partial formation of insoluble bismuth salts seemed removed. This in fact has proved to be the case, and the successful modified process for the assay of silver containing bismuth is as follows:—

The assay pound of silver bullion containing bismuth is dissolved in 5·5 cc. of nitric acid, sp. gr. 1200, with the aid of heat, about 5 ounces of water are added and then 10 cc. of nitric acid sp. gr. 1320. The silver is now precipitated by the addition of 2·5 cc. of hydrochloric acid, and after vigorous shaking the supernatant fluid will be found perfectly clear; and it will remain so when the bottle is filled up with water, all the bismuth present being in solution. Whenever samples of silver now show the presence of bismuth during the assay, a fresh set is taken up and worked by the modified process, the delay thus caused not amounting to more than a few minutes. It may be mentioned here that all our assays are reported to one-tenth of a millième (0·1 per mille).

Having thus ascertained the presence of bismuth in silver bullion and put in practice a modification of the assay process which renders us indifferent to its presence, it is still of importance to ascertain the exact proportion of bismuth which is present in the bullion; and, to be of practical use for mint work, this determination must be effected rapidly and as simply as possible. The ordinary directions given for the separation of bismuth in the presence of silver, by first removing the latter as chloride and then precipitating the bismuth as carbonate, do not, I find, give accurate results when silver is present in such overwhelming proportions as obtain in the cases under consideration.

I have therefore adopted the following plan, which a number of synthetically prepared solutions have proved to give quick and good results, though sometimes the amount of bismuth present is very slightly under-estimated. The ordinary silver assay having given a rough visual estimate of the amount of bismuth likely to be present, enough of the bullion is taken to yield a fairly weighable amount of bismuth oxide in the final result. The bullion is dissolved in a small amount of nitric acid, the solution carefully diluted, and an excess of ammonium carbonate at once added, the precipitation being aided by heating. The carbonates of silver and copper at first formed are re-dissolved, and the carbonate of bismuth after a time settles completely at the bottom of the beaker. The contents of the beaker are then passed through a filter, of which the weight of ash yielded by incineration is known, and the carbonate of bismuth on the filter washed quite free of all traces of silver. The filter is then dried, its contents transferred to a porcelain crucible for ignition, the filter paper being ignited separately, treated with a drop or two of nitric acid to re-oxidise any bismuth oxide reduced by contact with the carbon of the filter, and the ash added to the crucible. From the weight of bismuth oxide thus found, after deducting the weight of the filter ash, the amount of metallic bismuth present in the sample of bullion taken for analysis can be at once found.

There are only two metals likely to interfere with accuracy of the process here described, namely, cadmium and lead; the carbonates of both these metals being as insoluble in excess of the precipitant employed as bismuth carbonate. Cadmium is very unlikely to be found in silver bullion and its consideration may be neglected, but if the presence of lead is suspected the carbonate filtered from the silver solution is dissolved in nitric acid, evaporated down with the addition of sulphuric acid, and the lead sulphate formed (if any) collected and weighed in the usual way. The bismuth is again precipitated as carbonate and treated as before directed. Many experiments have been made with synthetically prepared mixtures of silver, copper, lead, and bismuth, the latter two metals being in very small proportion to the silver, so as to imitate the composition of some refined bars. Ullgreen's plan for the separation of the carbonates of lead and bismuth, by dissolving them in acetic acid and then precipitating the bismuth by means of a lead rod, does not work satisfactorily and requires too long a time for the precipitation.

II. As it seemed likely that a large number of experiments would be required to determine accurately the smallest amount of bismuth that would injure the ductility of our coinage alloy, and the still smaller proportion that would not sensibly affect this ductility, it was determined to begin the enquiry by a number of laboratory experiments on small bars of silver; before trying the effects of bismuth on ordinary coinage bars and with the procedure for lamination carried out in the Mint. These laboratory experiments were made in the following way: Pure silver prepared for assay check purposes, or an alloy of silver and copper of which the exact composition had been determined by assay, was melted in a clean plumbago crucible under charcoal. When the metal was in fusion the necessary amount of bismuth was rolled in a piece of paper, carried down at once to the bottom of the silver bath, and then thoroughly mixed with the silver by stirring. The calculated composition was confirmed by assay of the silver. When this mixture had been accomplished, the contents of the crucible were poured into an open iron ingot mould, and after cooling, either quickly by plunging the casting into water or slowly in contact with the mould, the bar so cast was tested for brittleness by hammering and rolling. The bars cast were of two sizes, one set being 3·75 inches long, 1·125 broad, 0·375 thick and weighing about 6·2 troy oz.; and another set 2·69 inches long, 1·125 broad, 0·25 thick and weighing about 4·1 troy oz. When reduced to the fullest extent by rolling, these bars were converted into straps about 0·015 in thickness. In laminating them they were twice annealed, first after having undergone four pinches in the rollers, and again after the tenth pinch from the beginning Similarly shaped bars of silver, without bismuth, were occasionally laminated in the same way to obtain a sure means of comparison. Before any result was accepted as to brittleness or its absence, the bar under experiment was always remelted and tried at least a second time. The number of experiments in this series amounted to *fifty-three*, and the following is a summary of the results obtained.

Fine silver when alloyed with only 1 per mille (one thousandth part of its weight) of bismuth, and the casting rapidly cooled by plunging it into water as soon as it has set, has its ductility, as tested by lamination, sensibly but slightly impaired, the straps resulting from rolling having slightly jagged edges. When the proportion of bismuth is increased to 2, 3, 4 and 5 per mille, the plan of cooling remaining the same, the raggedness of the edges of the straps was somewhat increased but not very markedly. If, however, the casting was allowed to cool down completely, but very slowly, in contact either with the mould or a stone floor, the results were very different. Under this condition of cooling, a bar composed of fine silver with 4 per mille of bismuth was completely brittle; it was readily broken and its fracture was strongly crystalline. On laminating it, small cracks appeared all over the surface on the second pinch, the bar emitting a crackling sound under the rolls, much like the " cry " of tin, and on the 4th pinch the bar cracked deeply at the edges. This remarkable effect on the molecular structure of this alloy of silver and bismuth, as due solely to the mode of cooling the casting, was repeatedly verified on the same metal by remelting and cooling rapidly and slowly alternately. The case seems analogous to that of bronze, where slow cooling of the alloy after casting is said to make it hard and brittle.

Fine silver with 6 per mille of bismuth, rapidly cooled, was distinctly cold-short and crystalline on fracture; the bar cracked on the surface at the 4th pinch. With 7 per mille of bismuth these evidences of diminished ductility were slightly more pronounced. With 8 per mille of bismuth the silver was still more brittle, the bar broke readily when hammered, and cracked all over the surface on the 4th pinch from the rolls. With 9, 10 and 11 per mille of bismuth, the bar of silver could be readily broken in two by merely striking it against the edge of an anvil, the fracture was coarsely crystalline, and the bar, in one case, proved to be very red-short, a mere tap from the tongs sufficing to break it in two when heated for the purpose of annealing. Although these bars were so very brittle, it was still possible to roll them into thin straps after careful annealing; but the edges of the straps so produced were deeply jagged and indented by cracks. These bars also all emitted the peculiar crackling noise under the rolls which has before been mentioned.

An alloy containing 990 parts of silver and 10 of copper then had added to it successively 1, 2, 3, 4, and 5 per mille of bismuth, the castings being rapidly cooled. The remarks already made with reference to fine silver alloyed with the same proportions of bismuth would apply here almost exactly, that is to say, the bars were rolled out to a thickness of 0·015 with somewhat ragged edges, so that, although ductility, as thus tested, was impaired, it was only slightly so. With 6 per mille of bismuth (fineness of metal on assay 983·9) the edges cracked a little, and, after annealing and rolling out, the strap had decidedly jagged edges and was split for some distance at one end. The bars containing 4, 5 and 6 per mille of bismuth were now remelted and allowed to cool slowly and completely in the mould. They were all found to be highly brittle, broke easily under the hammer—the fracture being granular and not crystalline—and on being rolled they cracked badly, all over the surface and at the edges, on the 1st or 2nd pinch; in one case the bar broke in two on the 2nd pinch. That these very different results were again solely due to the manner of cooling was proved by remelting and rapidly cooling the castings, when the same metal proved comparatively ductile, as first stated.

Silver of the Indian standard of 916·6 per mille (the rest being copper) to which 2 per mille of bismuth was added, gave on lamination straps with slightly jagged edges and proved to be red-short. With 4 per mille of bismuth the bars showed a few surface cracks on being rolled, and the resulting straps had decidedly jagged edges. Slow cooling of these castings did not affect their ductility, thus showing a marked contrast to what had been observed in the case of fine silver and the alloy containing only 10 per mille of copper. When the amount of bismuth was increased to 5 per mille, the copper present remaining at 83·4 per mille, the bars were decidedly brittle and cracked readily on hammering—the fracture being again granular, and not crystalline as in the case of fine silver. On lamination both surface and edge cracks developed after four pinches from the rolls, and in annealing one of these bars the whole surface blistered considerably, no doubt owing to the temperature having been carried a little too high. Standard silver with 10 per mille of bismuth, reducing the fineness as ascertained by assay to 906·6, was very brittle, the bars breaking easily under the hammer, and on the 4th pinch from the rolls splitting and cracking all over the surface. In the course of these latter experiments it was ascertained that with from 83·5 to 70 per mille of copper present slow or rapid cooling of silver alloys containing bismuth made no appreciable difference in their ductility.

The foregoing experiments having furnished some information as to the amount of bismuth that might be expected to injure our coinage alloy, it was now decided to test that point practically, by operating on coinage bars subjected to the regular procedure for the manufacture of rupees in the Calcutta Mint. The experiments made in this connection were *fourteen* in number. The bars used here for coinage weigh about 253 troy ozs. and are about 20 inches long, 2·25 broad, and 1 inch thick; they are cast in vertical iron moulds. In lamination they are first reduced by 11 pinches to a thickness of 0·23 in.; they are then annealed and finally reduced by 12 additional pinches to a thickness of 0·06 inch. A number of bars, poured from a pot of which the contents had proved on assay of a granulated sample to be 916·6 fine, were selected for the experiments, and as a preliminary step one of the bars was laminated to test its ductility. It rolled out with smooth "wire" edges, and indeed its ductility was beyond suspicion as it resulted from a melting of good coins. Another bar of the same batch was now melted and 1 per mille of bismuth added to it, the result of the addition being checked, in this and all following cases, by the assay of a granulated sample of the metal, taken after thorough stirring. At the 8th pinch both edges of the lower half of this bar began to crack, and at the 11th pinch these cracks extended towards the middle line of the strap for about a quarter of an inch, and occurred at about every half inch of the edge. After annealing, and in the subsequent lamination to a thickness of 0·065 inch, these cracks increased considerably in number, but did not become sensibly deeper. The strap as finished was pronounced unfit for coinage purposes; for although two blanks could have been cut from its width, the edges were too jagged to admit of the blanks being obtained exactly along the line from which it was desired to cut them—this position being attained by means of a fixed lateral guide against which the edge of the strap had to be maintained in cutting. With 2 per mille of bismuth the results obtained on rolling were not much worse than with 1 per mille. But the side cracks opened out more, and here again it was noticed that the lower portion of the bar (upper and lower here having reference to the casting in upright moulds) was somewhat less ductile than the upper part.

With 3 per mille of bismuth (fineness on assay 913·8) the bar began to crack on both edges at the 9th pinch; at the 11th pinch there were many cracks quite a quarter of an inch deep, and after annealing the bar these cracks increased at every pinch, so that at the 21st pinch the strap was cracked all along both edges very badly. It would only have been possible to obtain one blank from the width of this strap.

As it was perfectly clear that no further experiments were required with larger proportions of bismuth, the subsequent trials were made on coinage bars containing 0·5 per mille, 0·25 per mille, and, by dilution of the latter bars with standard silver, to even half and a quarter of the lesser proportion just stated. Here the results were rather discordant; they appear to have been somewhat influenced by the state of different rolls, and by quick or slow annealing. The general outcome of the tests, however, was that although some of the straps, containing the proportions given of bismuth, were jagged at the edges, and so would have yielded a diminished percentage in outturn of good blanks, others were not materially worse than the average of straps without any bismuth at all. As a result of this part of the enquiry, it may, I think, be fairly concluded that if our coinage bars contain less than 0·5 per mille of bismuth their ductility will not be materially affected. It must be borne in mind that these results only apply to bars of the size and shape of those experimented on, and with the particular treatment in lamination above detailed. With thinner bars and a different method of rolling, different results may be expected. The system of cutting out blanks has also to be considered, for in some mints straps with saw edges are not so prejudicial as in others.

III. We have now to consider the best way of dealing with silver tendered for coinage which is proved to contain bismuth; and a few remaining points.

The only experiment on a large scale for refining such silver here, as far as I know, has already been described. The want of success which attended it seemed to be due to the very small amount of base metal in the bullion, for the formation of a slag in which the bismuth oxide could be entangled and removed by skimming; and possibly the reducing action of the plumbago pots used may have added to the difficulty. As it seemed certain, however, that nitre would effect the desired oxidation of the bismuth, some experiments were tried in this direction on a small scale. About 20 troy ozs. of silver containing 2·5 per mille of bismuth, and no other metal in appreciable quantity, was melted in a *clay* pot and repeatedly treated with nitre and borax, the bath being skimmed from time to time. After prolonged treatment in this way, the fineness of the silver being three times tested by a dip assay, the report on the silver was raised from 997·5 to 999·2; so there can be no doubt that bismuth may be removed in this way. But the process, as several experiments showed, is tedious; and of course is attended with a loss of silver which in large operations would be of notable amount. Considering therefore that silver containing bismuth has hitherto only been met with at the Mint in bars of high fineness, and that these are not readily refinable by the ordinary process, it would seem as well, if such silver be accepted at all, to deal with the bismuth in it by the plan of *dilution*. The proportion of bismuth any silver contains being ascertained, it may, if convenient, be mixed by melting with sufficient silver free from bismuth, and with copper, so as to reduce the proportion of bismuth in the coinage bars to less than 0·5 per mille; and thus neutralize its injurious effects on the ductility of the bars.

The explanation of small quantities of bismuth being found in refined silver, *i. e.*, silver which has undergone parting for the extraction of the gold which was contained in it, seems sufficiently indicated in the following extract from Dr. Percy's work (Silver and Gold, Part I, p. 474), where that author is referring to the experience of Dr. Rössler in parting silver: "Bismuth has been found in nearly all kinds of silver; but in parting by sulphuric acid it is lost *partly in the fine silver* and partly in the slags." The italics are mine. That small quantities of bismuth adhere very tenaciously to silver, when once mixed with that metal by melting, is shown by the following experience. A quantity of silver containing bismuth, which had accumulated from the laboratory experiments before detailed, was melted, granulated, dissolved in nitric acid, and the silver precipitated as chloride. The silver chloride, after repeated washings, was reduced by heating in a plumbago pot with chalk and charcoal. The resulting ingots, on assay, showed at once that bismuth was still present in them in very appreciable quantity.

It may here be of interest to mention that I have found about 0·7 per mille of bismuth in some old Hindu punched coins, forming part of of a treasure trove which was found at Chaibassa, in the Singhbhum District.

The following is a summary of the main results detailed in this paper:—

1. The Indian assay process for silver bullion is, incidentally, a delicate qualitative test for the presence of bismuth in such bullion.

2. The assay process can be readily modified so as to give accurate results in the presence of such proportions of bismuth as are likely to be encountered in practice.

3. Fine silver when alloyed with only 1 per mille of bismuth has its ductility sensibly impaired thereby; and 1 per cent. of bismuth is sufficient to render fine silver, or alloys of it with copper down to 906 fine, extremely brittle.

4. Fine silver alloyed with small quantities of bismuth, and silver-copper alloys down to 980 fine when containing small proportions of bismuth, have the remarkable property of being more ductile when rapidly cooled in water after casting than if allowed to cool very slowly, thus resembling bronze in this respect.

5. Coinage bars such as are used in the Calcutta Mint, and with the procedure there adopted for rolling, are quite unfit for coinage

owing to brittleness, if they contain only 3 per mille of bismuth; while if the latter metal forms less than 0·5 per mille of the whole mass the ductility of the bars is not much affected.

In conclusion, I have much pleasure in recording my appreciation of the services of Messrs. J. R. L. Durham and E. Hood, Head and Second Assistants in the Assay Office, in carrying out under my directions many details of the experiments recorded in this paper.

Calcutta, March, 1887.

P. S.—June 10th. The experiments detailed in the foregoing paper were completed early in November 1886 and it was proposed to embody the conclusions formed in an official report to be submitted this year. It was suggested to me, however, that the subject investigated might be of general interest, and I had determined to publish this paper when I noticed in the Chemical News of March 21st, 1887, (p. 137), a short abstract of a paper on "Silver containing Bismuth" by Messrs. Gowland and Koga of the Japan Mint. I have delayed presenting this paper until I had read the full text of the communication from Japan (Journal of the Chemical Society No. CCXCIV, May, 1887, p. 410), and I may now make a few remarks upon it in connection with what I have advanced.

Messrs. Gowland and Koga's very interesting paper to a great extent covers ground which I had not investigated, *viz.*, the want of uniformity in composition of silver bullion containing bismuth. This part of the subject was suggested to me for experiment, as some of my results seemed to show that bismuth mixed with silver by melting and careful stirring does not diffuse itself evenly throughout the solidified mass. But that fact, now proved by Messrs. Gowland and Koga, was of no practical importance to us in the assay and valuation of bullion, seeing that it is an invariable rule now in the Calcutta Mint to premelt and assay by a granulated sample *every* kind of bullion tendered to the Mint—from refined bars 999·5 fine to Mexican Dollars. The well-known want of homogeneity in solidified silver-copper alloys, and other contingencies to which silver bullion is subject, render this course imperative for purposes of valuation on any extended scale. The cutting of samples from silver bullion for assay, even if the spot where such samples should be cut has been determined after most laborious investigation, can at best give merely approximate results; as indeed our authors admit for the case of silver containing bismuth.

With regard to the toughening or refining of silver containing bismuth, Messrs. Gowland and Koga mention that this operation is successfully performed in the Japan Mint by prolonged exposure of the molten metal to the oxidising action of the air, aided in some cases by the use of nitre. This may seem at variance with our experience here, but is probably not so after all. The brittle bullion treated in Japan evidently contained a considerable amount of base metal in addition to the bismuth; the slags formed in the early stages of the melting consisting chiefly of litharge, &c. What we had to deal with was refined silver 990 fine, and in this case of course it would be more difficult to free the bullion from bismuth than if lead and other base metals were present in sufficient quantity to form a copious slag. But in any case (without, however, venturing to give any authoritative opinion on the subject) I doubt whether the Indian Mints would willingly undertake any considerable refining operations on bullion. The conditions under which these Mints receive bullion are very different from those obtaining in the case of the American and Australian Mints, and the Imperial Mint of Japan. In those countries encouragement has to be given to native mining industries, and hence a good deal of work in the way of purification and separation of metals is undertaken by their mints. In India practically all the bullion is imported by banks and merchants, from Europe, America, and elsewhere, and tendered to the Mints for coinage at a fixed charge. The Indian Mints may therefore, as in the case of the Royal Mint in London, very properly require that all bullion tendered to them shall be free from taint of brittleness, and so far fit for coinage. It is for the importers to make sure that their purchases are satisfactory in this respect.

As to the amount of bismuth that will render silver brittle, my results seem to be substantially in accord with those of Messrs. Gowland and Koga. They found that pure silver alloyed with only 5 per mille of bismuth was very brittle; the casting, I suspect, was allowed to cool slowly. Coinage bars of 900 fine, containing nearly 14 per mille of bismuth, were brittle and altogether unfit for coinage, as I should have expected. But by special treatment in the way of repeated annealings, some of these bars were rolled down successfully without cracking, although they still could not be used for coinage.

In the other matters treated of in my paper the results obtained will supplement those of my *confrères* in Japan.

XI.—*On Monge's Differential Equation to all Conics.*—*By* ASUTOSH MUKHOPADHYAY, M. A., F. R. A. S., F. R. S. E., *Communicated by* THE HON'BLE MAHENDRALAL SIRCAR, M. D., C. I. E.

[Received June 30th;—Read July 6th, 1887.]

§. 1. *Introduction.*

The present paper relates to the general differential equation of all conics, which was first published by the French mathematician Gaspard Monge in his memoir "Sur les E'quations différentielles des Courbes du Second Degré," (Corresp. sur l'E'cole Polytech. Paris, 1809-13, t. II, pp. 51-54, and, Bulletin de la Soc. Philom. Paris, 1810, pp. 87-88). The subject seems to have attracted the notice of English mathematicians, from the following statement made by Boole in his Differential Equations, pp. 19—20:

"Monge has deduced the general differential equation of lines of the second order, expressed by the algebraic equation

$$ax^2+bxy+cy^2+ex+fy=1.$$

It is

$$9\left(\frac{d^2y}{dx^2}\right)^2\frac{d^5y}{dx^5}-45\,\frac{d^2y}{dx^2}\,\frac{d^3y}{dx^3}\,\frac{d^4y}{dx^4}+40\left(\frac{d^3y}{dx^3}\right)^3=0.$$

But, here our powers of geometrical interpretation fail, and results such as this can scarcely be otherwise useful than as a registry of integrable forms."

It will be noticed that Boole adds no specific reference; and as the equation was not found, even after diligent search, as well in the printed works of Monge as in his manuscripts, it was at one time believed that Boole had made a misquotation, till Professor Beman pointed out the source of Boole's statement (Nature, t. XXXIII, pp. 581-582). But I remark that the matter could have been settled in no time, by a reference to the *Royal Society Catalogue of Scientific Papers*, where Monge's memoir is actually mentioned (see Vol. IV, p. 441, tit. Monge, No. 22).* Lastly, it is to be noted that the subject has been very recently considered by Professor Sylvester, in his brilliant Lectures on the Theory of Reciprocants, which have been reported with commendable promptitude by Mr. Hammond in the American Journal of Mathematics (See, in particular, Vol. IX, pp. 18-19).

§. 2. *Derivation of the Mongian.*

We shall first consider the question of deriving the Mongian from the equation of the conic; the known methods are more or less lengthy and tedious; the easiest way known is that of Professor Michael Roberts, who gave the following theorem in the Dublin Examination Papers for 1876 (p. 269, Ques. 6):

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* Monge's Equation was also noticed by Lacroix; see his great work *Traité du Calcul Différentiel et du Calcul Intégral*, Paris, 1810—1819, t. III, pp. 698—699, as a note to § 634, t. II, pp. 371—372; I may add that Lacroix gives the reference to Monge's original memoir.

" Prove that

$$c\left(\frac{d^2y}{dx^2}\right)^{\frac{8}{3}}+c'\left(\frac{d^2y}{dx^2}\right)^{\frac{10}{3}}=\left(\frac{d^3y}{dx^3}\right)^2,$$

where c, c' are arbitrary constants, is a second integral of the differential equation of the fifth order which represents a conic section."

For Professor Wolstenholme's solution of this question, as well as for the method of obtaining the Mongian by twice differentiating the above equation, see Educational Times Reprint, Vol. XXIV, pp. 104-106, Question 4821; see also, Professor Burnside's Question 7104, in Vol. XXXVIII, p. 71. The method which I propose is as follows:

Let the equation of the conic be written in the standard form

(1) $ax^2+2hxy+by^2+2gx+2fy+c=0.$

Solving this as a quadratic in y, we have (*cf.* Salmon's *Conics*, p. 72, Ed. 1879)

(2) $by=-(hx+f)\pm\left\{(h^2-ab)x^2+2(hf-bg)x+(f^2-bc)\right\}^{\frac{1}{2}},$

which may be written,

(3) $y=\mathrm{P}x+\mathrm{Q}\pm\sqrt{\mathrm{A}x^2+2\mathrm{H}x+\mathrm{B}}.$

Operating on both sides with $\left(\dfrac{d}{dx}\right)^2$, we have

$$\frac{d^2y}{dx^2}=\pm\left(\frac{d}{dx}\right)^2\left[(\mathrm{A}x^2+2\mathrm{H}x+\mathrm{B})^{\frac{1}{2}}\right]$$

$$=\pm\frac{\mathrm{AB}-\mathrm{H}^2}{(\mathrm{A}x^2+2\mathrm{H}x+\mathrm{B})^{\frac{3}{2}}}$$

Therefore,

$$\left(\frac{d^2y}{dx^2}\right)^{-\frac{2}{3}}=\pm(\mathrm{AB}-\mathrm{H}^2)^{-\frac{2}{3}}(\mathrm{A}x^2+2\mathrm{H}x+\mathrm{B}).$$

Operating with $\left(\dfrac{d}{dx}\right)^3$, we have

$$\left(\frac{d}{dx}\right)^3\left[\left(\frac{d^2y}{dx^2}\right)^{-\frac{2}{3}}\right]=0,$$

which is accordingly the general differential equation to all conics; if we write it in its developed form, after performing the operations indicated, we have

$$9\left(\frac{d^2y}{dx^2}\right)^2\frac{d^5y}{dx^5}-45\,\frac{d^2y}{dx^2}\,\frac{d^3y}{dx^3}\,\frac{d^4y}{dx^4}+40\left(\frac{d^3y}{dx^3}\right)^3=0,$$

which is exactly the equation of Monge who wrote it in the now familiar form

$$9q^2t-45qrs+40r^3=0.$$

It may not be altogether uninstructive to point out that the ease with which the Mongian is derived above is simply due to the fact that, instead of differentiating (as other writers have done) the equation (1) which is an implicit function of x and y, we first express y as an explicit function of x in (3), and then proceed to the differentiation.

It is interesting to investigate the differential equations of all parabolas and circles by the above process. If the curve is a parabola, we have $h^2 = ab$ in the general equation (1), and (2) reduces to

$$by = -(hx+f) \pm \left\{ 2(hf-bg)x+(f^2-bc) \right\}^{\frac{1}{2}},$$

which may be written

$$y = \mathrm{P}x + \mathrm{Q} \pm \sqrt{\mathrm{R}x+\mathrm{S}}.$$

Operating on both sides, as before, with $\left(\frac{d}{dx}\right)^2$, we get

$$\frac{d^2y}{dx^2} = \pm \left(\frac{d}{dx}\right)^2 [(\mathrm{R}x+\mathrm{S})^{\frac{1}{2}}]$$

$$= \mp\frac{1}{4}\frac{\mathrm{R}^2}{(\mathrm{R}x+\mathrm{S})^{\frac{3}{2}}}.$$

Therefore,

$$\left(\frac{d^2y}{dx^2}\right)^{-\frac{2}{3}} \quad lx+m,$$

so that

$$\left(\frac{d}{dx}\right)^2\left[\left(\frac{d^2y}{dx^2}\right)^{-\frac{2}{3}}\right] = 0,$$

which is accordingly the general differential equation of all parabolas. When developed, this may be written

$$3\frac{d^2y}{dx^2}\frac{d^4x}{dx^4} = 5\left(\frac{d^3y}{dx^3}\right)^2,$$

which equation was given by Professor M. Roberts in the Dublin Examination Papers for 1875, (p. 277, Question 3).

If the curve is a circle, we must have $a = b$, $h = 0$ in the general equation (1), so that (2) becomes

$$ay = -f \pm \left\{ -a^2x^2 - 2agx + f^2 - ac \right\}^{\frac{1}{2}},$$

which may be written,

$$y = \mathrm{Q} \pm \sqrt{-x^2+2\mathrm{H}x+\mathrm{B}},$$

which leads to

$$\frac{dy}{dx} = \pm \frac{-x+\mathrm{H}}{(-x^2+2\mathrm{H}x+\mathrm{B})^{\frac{1}{2}}}$$

$$\frac{d^2y}{dx^2} = \pm \frac{-(\mathrm{B}+\mathrm{H}^2)}{(-x^2+2\mathrm{H}x+\mathrm{B})^{\frac{3}{2}}}.$$

From these, we have

$$1+\left(\frac{dy}{dx}\right)^2=\frac{B+H^2}{-x^2+2Hx+B}$$

and

$$\frac{\dfrac{d^2y}{dx^2}}{\left[1+\left(\left|\dfrac{dy}{dx}\right|^2\right)\right]^{\frac{3}{2}}}=\text{Constant},$$

whence the differential equation of all circles is

$$\left(\frac{d}{dx}\right)\left\{\frac{\dfrac{d^2y}{dx^2}}{\left[1+\left(\dfrac{dy}{dx}\right)^2\right]^{\frac{3}{2}}}\right.=0.$$

But, again, from the above values of $\frac{dy}{dx}$, $\frac{d^2y}{dx^2}$, we may derive

$$\left(\frac{dy}{dx}\right)\div\left(\frac{d^2y}{dx^2}\right)^{\frac{1}{3}}=\frac{H-x}{(B+H^2)^{\frac{1}{3}}},$$

whence

$$\left(\frac{d}{dx}\right)^2\left\{\frac{\dfrac{dy}{dx}}{\left(\dfrac{d^2y}{dx^2}\right)^{\frac{1}{3}}}\right\}=0,$$

or

$$3\left(\frac{d^2y}{dx^2}\right)^2\frac{d^3y}{dx^3}+4\frac{dy}{dx}\left(\frac{d^3y}{dx^3}\right)^2=3\frac{dy}{dx}\frac{d^2y}{dx^2}\frac{d^4y}{dx^4},$$

and this would also be the differential equation of all circles. But, then, if we examine this equation for a moment, we see that it contains $\frac{d^4y}{dx^4}$, and, therefore, the integral equation corresponding to it contains four arbitrary constants; hence the equation not only includes all circles, but something more, *viz.*, it denotes a certain family of conics which include all circles. In fact, if we integrate the equation, the result comes out in the form

$$Ax^2+By^2+2Gx+2Fy+C=0,$$

which represents conics referred to the centre.

§. 3. *First Method of integrating the Mongian.*

We shall next proceed to integrate the Mongian equation by ordinary methods. As far as we are aware (and the same view is apparently held by Boole and Sylvester), no direct integration of the equation has as yet been performed, except Professor Sylvester's solution by the Theory of Reciprocants (Amer. Jour. Vol. IX, pp. 18-19).

If we assume $\frac{d^2y}{dx^2} = z$, the equation reduces to

$$9z^2 \frac{d^3z}{dx^3} - 45z \frac{dz}{dx} \frac{d^2z}{dx^2} + 40 \left(\frac{dz}{dx}\right)^3 = 0.$$

As this is homogeneous in z and its differential coefficients, if we put

$$z = e^{\int u dx}$$

the equation is transformed into

$$9 \frac{d^2u}{dx^2} - 18u \frac{du}{dx} + 4u^3 = 0.$$

As this involves only the differential coefficients and the dependent variable, a legitimate transformation is to put $\frac{du}{dx} = v$, $\frac{d^2u}{dx^2} = \frac{dv}{dx} = v \frac{dv}{du}$, which give

$$9v \frac{dv}{du} - 18uv + 4u^3 = 0.$$

To separate the variables, assume

$$v = (\lambda + \tfrac{1}{3})u^2,$$

whence

$$\frac{dv}{du} = u^2 \frac{d\lambda}{du} + 2u(\lambda + \tfrac{1}{3}).$$

Substituting and simplifying, we have

$$u \frac{d\lambda}{du} = \frac{2\lambda - 6\lambda^2}{1 + 3\lambda},$$

where the variables are separated,

viz., $$2\frac{du}{u} = \frac{1+3\lambda}{\lambda(1-3\lambda)} d\lambda = \left\{ \frac{1}{\lambda} + \frac{6}{1-3\lambda} \right\} d\lambda.$$

Integrating,

$$2 \log ku = \log \lambda - 2 \log (1 - 3\lambda),$$

where k is the constant of integration.

Therefore $$k^2u^2(1 - 3\lambda)^2 = \lambda,$$

which is the complete primitive required. It now only remains to express u, λ in terms of x, y; for this purpose, it will be convenient to enumerate the successive transformations we have used, *viz.*,

$$\frac{d^2y}{dx^2} = z = e^{\int u dx},$$

$$\frac{du}{dx} = v = (\lambda + \tfrac{1}{3})u^2.$$

From these we get

$$\lambda = \frac{v - \frac{1}{3}u^2}{u^2}, \quad 1 - 3\lambda = 2 - \frac{3v}{u^2},$$

which, being substituted in the equation $k^2u^2(1-3\lambda)^2 = \lambda$, transform it into

$$k^2(2u^2-3v)^2 = v - \frac{u^2}{3},$$

which may be written

$$27k^2v^2 - 3(1+12k^2u^2)v + u^2(1+12k^2u^2) = 0.$$

Solving this as a quadratic in v, we have

$$18k^2v = (1+12k^2u^2) \pm (1+12k^2u^2)^{\frac{1}{2}}.$$

Introducing a new constant m, such that $12k^2m^2 = 1$, this may be written

$$v = \frac{du}{dx} = \tfrac{2}{3}\left\{ (u^2+m^2) \pm m(u^2+m^2)^{\frac{1}{2}} \right\},$$

which gives

$$\tfrac{2}{3}dx = \frac{du}{(u^2+m^2) \pm m(u + m^2)^{\frac{1}{2}}}.$$

Let

$$u = m \tan\phi.$$

Therefore

$$\tfrac{2}{3}dx = \frac{d\phi}{m(1 \pm \cos\phi)}$$

$$\frac{2m}{3}dx = \frac{d\phi}{2\cos^2\frac{\phi}{2}}, \text{ or, } \frac{d\phi}{2\sin^2\frac{\phi}{2}}$$

Integrating,

$$\frac{2mx}{3} + n = \tan\frac{\phi}{2}, \text{ or, } -\cot\frac{\phi}{2}.$$

But

$$\frac{u}{m} = \tan\phi = \frac{2\tan\frac{\phi}{2}}{1-\tan^2\frac{\phi}{2}}, \text{ or, } \frac{2\cot\frac{\phi}{2}}{\cot^2\frac{\phi}{2}-1}$$

$$= \frac{2\left(\frac{2mx}{3}+n\right)}{1-\left(\frac{2mx}{3}+n\right)^2}.$$

Hence,

$$\log z = \int u dx = m\int \frac{2\left(\frac{2mx}{3}+n\right)}{1-\left(\frac{2mx}{3}+n\right)^2} dx$$

$$= -\tfrac{3}{2}\log p\left\{1-\left(\frac{2mx}{3}+n\right)^2\right\}$$

Therefore

$$z = p^{-\frac{3}{2}} \left\{ 1 - \left(\frac{2mx}{3} + n \right)^2 \right\}^{-\frac{3}{2}},$$

and

$$\frac{d^2y}{dx^2} = \left\{ \mathrm{A}'x^2 + 2\mathrm{H}'x + \mathrm{B}' \right\}^{-\frac{3}{2}},$$

whence, by two simple integrations, we easily pass to

$$y = \mathrm{P}x + \mathrm{Q} \pm \sqrt{\mathrm{A}x^2 + 2\mathrm{H}x + \mathrm{B}},$$

which at once leads to

$$ax^2 + 2hxy + by^2 + 2gx + 2fy + c = 0,$$

the general conic-primitive sought.

§. 4. *Second method of integrating the Mongian.*

We shall next proceed to shew how the Mongian equation may be integrated by means of an integrating factor. The equation being written, as before, in the form

$$9z^2 \frac{d^3z}{dx^3} - 45z \frac{dz}{dx} \frac{d^2z}{dx^2} + 40 \left(\frac{dz}{dx} \right)^3 = 0,$$

if we multiply this by the integrating factor $z^{-\frac{11}{3}}$, it may be written,

$$^{-\frac{5}{3}} \frac{d^3z}{dx^3} - 5z^{-\frac{8}{3}} \frac{dz}{dx} \frac{d^2z}{dx^2} + \frac{40}{9} z^{-\frac{11}{3}} \left(\frac{dz}{dx} \right)^3 = 0.$$

By the application of ordinary methods (Boole, pp. 222—226. Forsyth, pp. 82—85), the left hand member is seen to be a perfect differential, and, integrating, we get

$$z^{-\frac{5}{3}} \frac{d^2z}{dx^2} - \frac{5}{3} z^{-\frac{8}{3}} \left(\frac{dz}{dx} \right)^2 = -3c_1,$$

which may be written

$$\frac{d}{dx} \left\{ z^{-\frac{5}{3}} \frac{dz}{dx} \right\} = -3c_1,$$

whence

$$z^{-\frac{5}{3}} \frac{dz}{dx} = -3c_1x + 3c_2.$$

Integrating again,

$$z^{-\frac{2}{3}} = c_1x^2 - 2c_2x + c_3,$$

whence

$$z = \frac{d^2y}{dx^2} = (c_1x^2 - 2c_2x + c_3)^{-\frac{3}{2}},$$

and the solution may be completed as before by two simple integrations.

It is worth noting that though this second method is apparently much shorter than the first method, it may seem to be rather artificial in the absence of any clue to the discovery of the proper integrating factor; the process, however, has the merit of furnishing an immediate proof of Professor Roberts' theorem, quoted above in §. 2. Thus, since

$$z^{-\frac{5}{3}}\frac{dz}{dx} = -3c_1x+3c_2,$$

we have

$$\begin{aligned} z^{-\frac{10}{3}}\left(\frac{dz}{dx}\right)^2 &= 9c_1^2x^2-18c_1c_2x+9c_2^2 \\ &= 9c_1(c_1x^2-2c_2x+c_3)+9(c_2^2-c_1c_3) \\ &= 9c_1z^{-\frac{2}{3}}+9(c_2^2-c_1c_3). \end{aligned}$$

Multiplying both sides by $z^{\frac{10}{3}}$, and then substituting $z = \frac{d^2y}{dx^2}$, $9c_1 = c$, and $9(c_2^2-c_1c_3) = c'$, we get

$$\left(\frac{d^2y}{dx^2}\right)^{\frac{8}{3}}+c'\left(\frac{d^2y}{dx^2}\right)^{\frac{10}{3}} = \left(\frac{d^3y}{dx^3}\right)^2,$$

which is exactly Roberts' theorem quoted above; and this not only shews that the Mongian can be derived from this equation, but also that it is a second integral of the Mongian.

§. 5. *Permanency of Form.*

Professor Sylvester has remarked that the Mongian equation has permanency of form, that is to say, if we seek the transformation of the Mongian when y is the independent and x the dependent variable, the required formula is obtained by interchanging x and y in the Mongian; this theorem, which is proved from the properties of projective reciprocants, may easily be established as follows. Corresponding to the integral equation

(4) $ax^2+2hxy+by^2+2gx+2fy+c = 0,$

we have Monge's differential equation. If we interchange x, y, we get, corresponding to the integral equation

(5) $ay^2+2hyx+bx^2+2gy+2fx+c = 0,$

the differential equation

$$(6)\quad 9\left(\frac{d^2x}{dy^2}\right)^2\frac{d^5x}{dy^5}-45\frac{d^2x}{dy^2}\frac{d^3x}{dy^3}\frac{d^4x}{dy^4}+40\left(\frac{d^3x}{dy^3}\right)^3 = 0.$$

But the equation (5) represents a conic, and as all conics are represented by the Mongian, the Mongian corresponds to (5); but, as (6) also corresponds to (5), we see that the Mongian and (6) are identical, or mutually transformable, which establishes the theorem in question.

By a similar reasoning, we can prove that the equation

$$3\,\frac{d^2y}{dx^2}\,\frac{d^4y}{dx^4}=5\left(\frac{d^3y}{dx^3}\right)^2,$$

which denotes all parabolas, the equation

$$3\left(\frac{d^2y}{dx^2}\right)^2\frac{d^3y}{dx^3}+4\,\frac{dy}{dx}\left(\frac{d^3y}{dx^3}\right)^2=3\,\frac{dy}{dx}\,\frac{d^2y}{dx^2}\,\frac{d^4y}{dx^4},$$

which represents all conics referred to co-ordinate axes through the centre, the equation

$$x\left(\frac{dy}{dx}\right)^2+xy\,\frac{d^2y}{dx^2}=y\,\frac{dy}{dx},$$

which represents all conics referred to principal axes through the centre, the equation

$$\left(x\,\frac{dy}{dx}-y\right)\frac{dy}{dx}=2xy\,\frac{d^2y}{dx^2},$$

which represents all parabolas referred to two tangents as axes, and the equation

$$1+\left(\frac{dy}{dx}\right)^2\Big\}\,\frac{d^3y}{dx^3}=3\,\frac{dy}{dx}\left(\frac{d^2y}{dx^2}\right)^2,$$

which represents all circles, have permanency of form. Of course, by actual calculation we can establish that, if in each of these equations we make y the independent and x the dependent variable, we have simply to interchange x and y. We subjoin below the formulæ necessary for such a verification.

$$\frac{dy}{dx}=\frac{1}{\dfrac{dx}{dy}}$$

$$\frac{d^2y}{dx^2}=-\frac{\dfrac{d^2x}{dy^2}}{\left(\dfrac{dx}{dy}\right)^3}$$

$$\frac{d^3y}{dx^3}=\frac{3\left(\dfrac{d^2x}{dy^2}\right)^2-\dfrac{dx}{dy}\,\dfrac{d^3x}{dy^3}}{\left(\dfrac{dx}{dy}\right)^5}$$

$$\frac{d^4y}{dx^4}=\frac{10\,\dfrac{dx}{dy}\,\dfrac{d^2x}{dy^2}\,\dfrac{d^3x}{dy^3}-\left(\dfrac{dx}{dy}\right)^2\dfrac{d^4x}{dy^4}-15\left(\dfrac{d^2x}{dy^2}\right)^3}{\left(\dfrac{dx}{dy}\right)^7}$$

$$\frac{d^5y}{} = \frac{105\left(\frac{d^2x}{d^2y}\right)^4 - 105\,\frac{dx}{dy}\left(\frac{d^2x}{dy^2}\right)^2\frac{d^3x}{dy^3}}{\left(\frac{dx}{dy}\right)^9}$$

$$+\frac{5\left(\frac{dx}{dy}\right)^2\left\{3\,\frac{d^2x}{dy^2}\,\frac{d^4x}{dy^4}+2\left(\frac{d^3x}{dy^3}\right)^2\right\} - \left(\frac{dx}{dy}\right)^3\frac{d^5x}{dy^5}}{\left(\frac{dx}{dy}\right)^9}.$$

From the character of these formulæ, it must be evident that considerable calculation is unavoidable even in the simplest cases of verification.

§. 6. *Geometrical Interpretation.*

We shall, in the last place, refer to the geometrical signification of the Mongian equation. It will be seen from the passage quoted above (§. 1) from Boole, that he regarded this as a case where our powers of geometrical interpretation fail. With respect to this passage, Professor Sylvester, in his Lectures on the Theory of Reciprocants already mentioned (Amer. Jour., Vol. IX, p. 18), remarks, "The theory of reciprocants, however, furnishes both a simple interpretation of the Mongian equation, and an obvious method of integrating it"; and the geometrical interpretation which the learned professor arrives at, is that the differential equation of a conic is satisfied at the sextactic points of any given curve. With regard to this geometric interpretation, it may be remarked that it was not necessary to call in the aid of the theory of reciprocants to establish this theorem. The theorem is self-evident from the very definition of a sextactic point as one where an infinite number of conics can be drawn having five-pointic contact with the given curve; the integral equation of a conic, with its five available arbitrary constants, denotes a determinable conic for any given values of the constants, while the differential equation, being free from constants, appropriately and adequately represents all conics; and, as an infinite number of conics may be made to pass through a sextactic point, the Mongian must be satisfied at such a point. But, apart from this, and with all deference to the opinion of Professor Sylvester as that of one of the greatest of living mathematicians, I believe that his geometrical interpretation is *not* the one contemplated by Boole. A careful examination of the section on "geometrical illustrations" (Boole, pp. 18—20) will make it clear that, by the process of the geometrical interpretation of the differential equation of a curve, Boole meant the determination of some particular geometrical property which belonged to every curve of the system covered by the differential equation, and the inherence of which property was adequately represented by the equation; take, for example, the case of the circle, of which the differential equation is

$$\left\{ 1+\left(\frac{dy}{dx}\right)^2 \right\} \frac{d^3y}{dx^3} - 3\frac{dy}{dx}\left(\frac{d^2y}{dx^2}\right)^2 = 0.$$

Boole points out that this equation represents in an "absolute character" the geometrical fact of the invariability of the radius of curvature of all circles; in fact, I may remark in passing that this equation represents the vanishing of the angle of aberrancy at every point of every circle; for, if δ be the angle of aberrancy, and, p, q, r, the first, second, and third differential coefficients of y in regard to x, we have the formula

$$\tan\delta = p - \frac{(1+p^2)r}{3q^2}.$$

(See Salmon's Higher Plane Curves, p. 369, Ed. 1879). Hence, when the angle of aberrancy vanishes, we have

$$(1+p^2)r = 3pq^2,$$

which is the differential equation of all circles. We see, then, that the differential equation of a circle is the "absolute" analytical representation of some geometrical property which belongs to all circles, and the existence of which is manifested by the differential equation. But Professor Sylvester's interpretation of the Mongian equation is of an entirely different character; it does not furnish us with some property common to all conics; it is simply regarded as the representative of a sextactic point on any curve. What Boole wanted was some intrinsic property, that is, a property belonging to the curve whose differential equation we are interpreting; what Professor Sylvester arrives at, is, if I am allowed the expression, an extrinsic property, that is to say, a property belonging *not* to the curve in question, but to some *extraneous* curve which has six-point contact with the given one. If Professor Sylvester's interpretation were the one contemplated by Boole, nothing would be easier than to interpret a differential equation. Thus, for example, with reference to the differential equation of a circle, we might simply say that it is satisfied at a quadruple point on any curve. Again, the equation

$$3\frac{d^2y}{dx^2}\frac{d^4y}{dx^4} = 5\left(\frac{d^3y}{dx^3}\right)^2$$

when integrated, is found to represent all parabolas; but would it be a sufficient geometrical interpretation to say that the equation is satisfied at a quintic point on any curve? The whole point of the matter is, it seems to me, that the property discovered must belong to the curve with which alone we are concerned, and must also be represented by the differential equation to be interpreted. We miss the mark, if we bring in any other curve which is totally foreign to our purpose. I believe, then, that though the theorem enunciated by Professor Sylvester is perfectly correct, it is *not* the geometrical interpretation of the Mongian equation as contemplated by Boole; what Boole sought for in vain, has yet to be discovered.

26*th June* 1887.

XII.—*Notes on Indian* RHYNCHOTA, HETEROPTERA, No. 2.

By E. T. ATKINSON, B. A., PRESIDENT.

[Received May 25th, 1887;—Read June 1st, 1887.]

Fam. PENTATOMIDÆ.

Subfam. SCUTELLERINA, Stål.

En. Hem. i, p. 4 (1870); iii, p. 3 (1873):—*Scutellerides, Pachycorides, Tetyyrides* and *Eurygastrides*, pt, Am. & Serv., Hist. Nat. Ins. Hém. pp. 25-51 (1843):—*Praanguli* pt, Amyot, A. S. E. F. (2 s.) iii, p. 401 (1845):—*Pachycoridæ* and *Eurygastridæ*, Dallas, List Hem. i, p. 3, 43 (1851); Walker, Cat. Het. i, p. 1, 61 (1867):—*Scutellerida*, Stål, Hem. Afric. i, p. 32, 33 (1864); Hem. Fabr. i, p. 9 (1868).

Primary and subtended veins of wings distant, including a broad area in the middle: hamus present: scutellum very large, without frena.

Div. ELVISURARIA, Stål.

Meso- and meta-sternum with two high wrinkles or ridges, those on the former higher forwards: thorax and scutellum at base, together gradually convex; thorax, at base, produced hindward between the basal angles of the scutellum: second joint of rostrum much shorter than the two apical joints taken together, and a little longer than the apical joint: venter furrowed, without stridulatory strigose spots, incisures gradually curved on the disc.

Genus OXYPRYMNA, Stål.

En. Hem. iii, p. 5 (1873):—*Elvisura*, Stål (nec Spinola) Hem. Afric, i, p. 35 (1864.)

Venter with a distinct broad furrow continued through it: scutellum with a small spine at the apex. In *Elvisura*, the spine is wanting.

58. OXYPRYMNA SPINOLÆ, Sign.

Elvisura spinollæ, Sign., A. S. E. F. (4 s.) i, p. 55, t. 2, f. 5 (1861); Walker Cat. Het. i, p. 61 (1867).
Oxyprymna spinolæ, Stål, En. Hém. iii, p. 5 (1873).

Black shining: the head, pronotum, scutellum and especially the abdomen, covered with a grey, powdery, pubescence: pronotum and scutellum with round yellow spots. Head stout, rounded in front, the tylus not extending beyond the juga; the lateral margins weakly sinuate; eyes a little prominent; ocelli equally distant from the eyes and the median line and somewhat near the posterior border; entire head, above and below, except some weakly convex portions, covered with a greyish pubescence which when removed discloses an extremely fine punctuation: anterior border of pronotum straight, sides scarcely sinuated, posterior border strongly rounded, and extending over the scutellum; posterior angles obtusely rounded; near the anterior border are some depressions in which is the grey pubescence, also on the sides and behind the posterior angles; on the disc are some small, round, yellowish marks: scutellum acuminate at the tip, reaching the end of the abdomen, and furnished with a strong median ridge; on each side, near the lateral borders, are depressions clothed with the grey pubescence, and on the disc 6-7 small yellowish patches like those on the pronotum, and towards the second-third a punctured, yellowish band: hemelytra extending weakly beyond the scutellum: abdomen with a strong median groove and covered with a silken grey pubescence, very abundant: feet short, stout, covered with the same pubescence. (*Sign.*) Long, 16; broad 9 mill. Reported from India.

Genus SOLENOSTETHIUM, Spinola.

Solenosthedium, Spinola, Ess. p. 360 (1837); Dallas. List Hem. i, p. 36 (1851)). *Solenostethium*, Am. & Serv., Hist. Nat. Ins. Hém. p. 26 (1843); Mayr, Reise Novara, Hem. p. 13 (1866); Stål, En. Hem. iii, p. 5 (1873). Includes *Cœloglossa*, Germar, Zeitschr. i (i) p. 130 (1839); Herr. Schäff., Wanz. Ins. v, p. 59 (1839); Stål, Hem. Afric. i, pp. 35, 52 (1864).

Body obovate: head a little convex, triangular, rather inclined and flattened; eyes rather stout, globose; ocelli more distant from each other than from the eyes; tylus longer than the juga; antennæ, slender, 5-jointed, somewhat short, second joint shortest, 3-5 joints successively increasing in length: first joint of rostrum not extending beyond the lower surface of the head, fourth joint reaching the end of the rostral canal, between the third pair of feet: thorax sexangular, basal produced part truncate, basal margin straight, posterior and lateral angles rounded: scutellum very large, as broad as the abdomen: sterna and venter furrowed, the sternal furrow ended on both sides by a high ridge, the mesosternal ridges not produced anteriorly: venter in ♂ with two large, opaque, remotely somewhat-pilose spots: tibiæ cylindrical, above slightly bisubsulcate, furnished with a median ridge, margined on both sides *(Spin., Stål)*.

59. SOLENOSTETHIUM RUBRO-PUNCTATUM, Guérin.

Scutellera rubro-punctata, Guérin, Voy. Coq. Zool. ii. (2) p. 157 (1838).

Solenosthedium rubro-punctatum, Dallas, List Hem. i, p. 7 (1851).

Solenostedium rubro-punctatum, Voll., Faune Ent. l'Arch. Indo-Néer. i, p. 4, t. 1, f. 1 (♂) (1843): Walker, Cat. Het. i, p. 4 (1867).

Solenostethium rubropunctatum, Stål, En. Hem. iii, p. 6 (1873): Distant, A. M. N. H. (5 s.) iii, p. 44 (1879).

Head, thorax and scutellum of a rather deep reddish brown: head triangular, immaculate, with a small longitudinal elevation in the middle; antennæ black: thorax sprinkled with numerous, very small, indistinct, green dots; three round orange spots on each side, of which one on the anterior margin immediately behind the eyes, another in the middle and a third near the posterior margin; anteriorly a seventh spot in the middle: the scutellum is without green dots and has six orange spots at the base at an equal distance from each other, and four in the middle behind these, also at an equal distance from each other: body beneath ferruginous yellow with a small black spot on each side of each segment of the abdomen: femora reddish, with the tibiæ and tarsi black (*Guérin*). Long, 13; broad 8½ mill.

Reported from China, Java, Assam. The Indian Museum has specimens from Naga hills, Sikkim. The ♂ has 10, the ♀ 8 spots on the scutellum. *S. chinense*, Stål, is probably only a local variety, as the links between it and *S. rubro-punctatum* are nearly complete.

Div. SPHÆROCORARIA, Stål.

Meso- and meta-sternum without ridges, sometimes furrowed. Body above very convex, beneath very slightly so: head transverse, very much inclined or perpendicular: thorax and scutellum at the base, together, gradually longitudinally convex, basal margin of thorax obtusely rounded towards the basal angles of the scutellum, posterior angles usually obtusely rounded, not distinguishable as angles: second joint of the rostrum much shorter than the two apical together: venter without stridulatory, strigose spots, incisures gradually curved towards the middle.

Genus HYPERONCUS, Stål.

Ofvers. K. V.-A. Förh. p. 615 (1870); En. Hem. iii, p. 7 (1873).

Body obovate, above much, beneath slightly convex: head much inclined, triangular, with the eyes broader than long, very slightly convex, lateral margins slightly sinuate near the eyes: rostrum reaching the apex of the third ventral segment, second and third joints almost equally long, first and fourth shorter than them: antennæ 5-jointed (?), first joint not reaching the apex of the head: thorax sexangular, anterior margin very broadly sinuate between the eyes, anterior lateral margins subacute not retusely-sinuated before the lateral angles, basal margin straight, posterior angles obtusely rounded: scutellum as broad as the abdomen, gradually less convex towards the posterior part, anterior margin of prostethium obtusely roundly-dilated towards the coxæ: mesosternum slightly sulcated: odoriferous openings continued outwards in a long furrow: venter longitudinally, slightly furrowed before the middle, sides flat, margins acute, incisures gradually curved in the middle: feet somewhat shortish, tibiæ furnished with two furrows above. Differs from *Sphærocoris* in having the anterior lateral margins of the thorax not retusely sinuated at the lateral angles, the sixth ventral segment in ♂ is roundly produced at the apex and covers the genital segment and in ♀ is arcuately sinuate, leaving the genital valvules free, also the tibiæ above are slightly somewhat 2-furrowed, with a distinct wrinkle between the furrows.

60. HYPERONCUS LATERITIUS, Westwood.

Sphærocoris lateritia, Westw., Hope, Cat. Hem. i, p. 13 (1837).

Sphærocoris lateritius, Germar, Zeitschr. i (i) p. 79 (1839): Dallas, List Hem. i, p. 10 (1851); Walker, Cat. Het. i, p. 6 (1867).

Hyperoncus lateritius, Stål, En. Hem. iii, p. 7 (1873).

Obscurely rufescent, much punctured: pronotum with four dots arranged in a transverse line; scutellum with twelve (six, four, two); body beneath antennæ and feet, rufescent; abdomen with a large basal spot (*Westw.*). Body long 11-11½ millims.

Reported from China: there is a doubtful specimen in the Indian museum from the Dikrang valley (Assam).

Div. SCUTELLARIA, Stål.

Meso- and meta-sternum without wrinkles or ridges, sometimes furrowed: body beneath distinctly convex, generally above and below equally convex or beneath more convex. Thorax at the base hindwards, scutellum at the basef orwards, more or less convexly-inclined which is best seen from the side; thorax generally distinctly truncated posteriorly before the entire base of the scutellum, basal angles generally very distinct, situate before or outside the basal angles of the scutellum: venter without stridulatory strigose spots, rarely in ♂ with two opaque spots, incisures gradually curved towards the middle: second joint of rostrum generally shorter and often much shorter than the two apical joints taken together.

Genus CANTAO, Am. & Serv.

Hist. Nat. Ins. Hém. p. 29 (1843); Dallas, List Hem. i, p. 3, 17 (1851); Walker, Cat. Het. i, p. 14 (1867): Stål, Hem. Afric, i, p. 33 (1864); En. Hem. iii, pp. 8, 10, (1873); Mayr, Reise Novara, p. 14 (1866).

Body narrowly obovate, elongate: head narrow, elongate, lateral margins slightly sinuate; rostrum not extending beyond the first segment of the abdomen: pronotum broader than long, basal margin straight towards the sides, posterior angles very distinct, dentated, no transverse furrow; scutellum as broad as the abdomen, longer, distinctly impressed at the base near the angles, somewhat truncate or flattened at the tip; exterior margin of corium straight; membrane extending beyond the end of abdomen; anterior margin of propleura entirely obtuse, somewhat callous, posterior margin not sinuate at the angles: venter without opaque spots, with a longitudinal groove in the middle, sides more or less convex, genital segment in ♂ duplicate or divided into two parts, the basal rounded at its tip, the other extremely trilobed and truncate at the tip; vulvar plates in ♀, narrow.

61. CANTAO OCELLATUS, Thunberg.

Cimex ocellatus, Thunberg, Nov. Ins. Spec. iii, p. 60, f. 72 (1784): Gmelin, ed. Syst. Nat. i (4), p. 2133 (1788).

Cimex dispar, Fabr., Ent. Syst. iv, p. 81 (1794); Donovan, Ins. China, Hem., t. 13, f. 1 (1798), sec. Dallas: Stoll, Punaises, p. 143, t. 37, f. 260 A. & B. (1788).

Tetyra dispar, Fabr., Syst. Rhyng. p. 129 (1803); Schiödte, Kroyer's Nat. Tidsskr., iv, p. 281 (1842).

Callidea dispar, Burm., Handb. ii (i) p. 394 (1835); Herr. Schäff., Wanz. Ins. iii, p. 99, t. 105, f. 324 (1835).

Calliphara dispar, Germar, Zeitschr., i (i) p. 123 (1839).

Callidea ocellata, Westw., Donovan l. c. p. 47, t. 20, f. 1. (1842).

Scutellera dispar, Blanchard, Hist. Nat. Ins. iii, p. 158, Hém. t. 8, f. 2 (1840).

Cantao dispar, Am. & Serv., Hist. Ins. Hém. p. 29 (1843).

Cantao rufipes, Dallas, List Hem. i, p. 17 (1851); Walker, Cat. Het. i, p. 14 (1867).

Cantao ocellatus, Dallas, l. c. p. 17 (1851); Vollen., Faune Ent. l' Arch. Indo-Néerl., i, p. 10 (1863); Walker, l. c., p. 14 (1867); Stål, Hem. Fabr., i p. 9 (1868); Ofvers. K. V.-A. Förh. p. 616 (1870); En. Hem. iii, p. 10 (1873): Distant, A. M. N. H. (5 s.) iii, p. 44 (1879).

Orange yellow or carneous: head yellow, the base and antennæ cœrulean: pronotum and scutellum carneous, the former with sometimes many, sometimes fewer flavescent spots, some with a black point scutellum large, with a small impressed moon-shaped black spot on each side at the base, then three yellow rings marked with a black point, the median larger, behind the middle are two small yellow lunules spotted black and posteriorly rings with a black point in the middle: pectus cyaneous: abdomen carneous with four cyaneous macular striæ; of which the median are larger: feet cyaneous, femora rufous: varies with the sex, with thorax having on both sides a very acute, incurved porrect spine, yellow at base, black at apex (*C. dispar*, Fabr.). Long 14-23 mill. Very variable in the colour above, from a pale sordid yellow to a deep rich orange-red, and in the spots on the pronotum and scutellum, from almost immaculate with merely traces of spots, to the full number; all these varieties occur in India.

Reported from Java, Sumatra, Philippines, China, India. The Indian Museum has specimens from Assam, Sikkim, N. India, Malabar, Ceylon, China.

Genus PŒCILOCORIS, White, Dallas.

Pœcilochroma, White, Trans. Ent. Soc. iii, p. 84 (1842): Stål, En. Hem. iii, p. 11 (1873): *Pœcilocoris*, Dallas, Trans. Ent. Soc. v, p. 100 (1848); List Hem. i, p. 4 (1851); Stål, Hem. Afric., i, p. 33 (1864); Mayr, Reise Novara, Hem., p. 17 (1866); Walker, Cat. Het. i, p. 8 (1867). The name *Pœcilochroma* was used by Stephens in 1829 for a Lepidopterous genus of *Tortrices*, and Dallas with White's consent changed the name of the Hemipterous genus to *Pœcilocoris* in 1848 and described it for the first time, so that for very good reasons, the new name must stand.

Body ovate, convex: head rather large, broad, the lateral margins sinuated before the eyes: antennæ about half the length of the body, 5-jointed; basal joint short, robust; second, shorter and most slender; 3-5 joints each as long as, or longer, than the two basal united, nearly equal, compressed, broad and furrowed longitudinally on the sides: rostrum usually extending beyond the second segment of the abdomen, sometimes nearly to its apex: scutellum slightly truncated at the apex: abdomen with a more or less distinct furrow beneath; the three penultimate segments in the ♂ not bearing the dull space on each side which exists in *Tectocoris*, Hahn, and the anal plate, in ♂, simple, formed of one piece, sinuated at the tip and fringed with hairs (*Dallas*).

62. PŒCILOCORIS HARDWICKII, Westwood.

Tectocoris Hardwickii, Westwood, Hope, Cat. i, p. 13 (1837).
Tectocoris affinis, Westwood, l. c. p. 13 (1837).
Pachycoris nepalensis, Herr. Schäff. Wanz. Ins. iv, p. 1. t. 109, f. 339 (1839).

Scutellera Hardwickii, Germar, Zeitschr. i (i) p. 135 (1839).

Pœcilochroma Hardwickii, Stål, En. Hem. iii, p. 12 (1873); Distant, A. M. N. H. (5 s.), iii, p. 44 (1879).

Pœcilocoris Hardwickii, Dallas, Trans. E. S. v, p. 107, t. 13, f. 8 (1848): List Hem. i, p. 13, (1851); Walker, Cat. Het. i. p. 8 (1867).

♂, ♀. Ovate, convex, above yellowish orange or red, opaque, rather finely and thickly punctured, head black, thickly and strongly punctured; eyes and ocelli brownish: pronotum with the anterior portion and two large spots on the disc, black: scutellum slightly wrinkled transversely at the base; normally, with eleven black spots, placed, three at the base of which the median one is large and elongated-triangular, a small round one on each side of the apex of this, a transverse row of four across the disc, behind the middle, the two intermediate of which are the largest and the two smaller towards the apex; these spots are generally more or less confluent or partially obsolete, forming several varieties: margins of the hemelytra black piceous: abdomen beneath orange-red, very faintly wrinkled, the basal segment entirely, the second (except the middle), the third and fourth on the lateral margins, the terminal segment, except its lateral margins, (and in the ♂, the base) and the anal apparatus, violet-black; the penultimate segment is entirely red: pectus black, tinted with violet, finely punctured; the lateral angles of the prostethium and part of the antero-lateral margins, red: legs violet-black: antennæ and rostrum black. Dallas remarks that in *P. nepalensis*, Herr. Schäff., the spots have become confluent so that the general colour of the upper surface is black: the pronotum is nearly covered by the two spots on the disc which extend forwards to the black anterior margin and posteriorly to the hinder margin; the five spots at the base of the scutellum are united, forming a large waved band across the base, from the middle of which the apex of the triangular basal spot projects, while the two intermediate spots of the transverse row are joined to one another and to the two subapical ones, forming a large, rounded lobate patch. In *P. affinis*, Westwood, the two subbasal and the two subapical spots are wanting and the two spots on the disc are sometimes obsolete. There are numerous varieties between these, but all are distinguishable by the uniform red colour of the fifth abdominal segment (*Dallas*). Body long, 17-20 mill. a very variable species: in some the spots are large and confluent so as to make the general appearance of the upper surface of the scutellum black, and in others red is the prevailing colour. *P. nepalensis*, Herr. Schäff., if not specifically different, forms a well marked variety. Obovate, moderately convex; black, shining, finely and closely punctured, on the antennæ, feet and the underside, bright shining violet: the posterior greater part of the thorax (except two round black spots), a broad transverse band above the middle of the scutellum having forwards four and hindwards three obtuse teeth, and the apical margin of the scutellum, sanguineous. In it, the subbasal spots on the scutellum are confluent so as to form a black band more or less broad, posteriorly dentate; whilst in *T. affinis*, Westwood both the sub-basal and sub-apical spots are wanting. *P. hardwickii* in Dallas' figure, forms the mean between these two extremes.

Reported from India, Nepál, Silhat: the Indian Museum has specimens from the Khasiya and Nága hills, Sibságar and Sikkim.

63. PŒCILOCORIS LATUS, Dallas.

Pœcilocoris latus, Dallas, Trans. Ent. Soc. v, p. 101, t. 13, f. 4 (1843); List Hem. i, p. 12 (1851); Walker, Cat. Het. i, p. 9 (1867).

Pœcilochroma lata, Stål, En. Hem. iii, p. 12 (1873).

♂, ♀, Rounded-ovate, not very convex; above yellow, clouded with orange-red, thickly punctured: head violet, shining, thickly and strongly punctured; eyes brown; ocelli red: pronotum thickly punctured, somewhat rugose, with the anterior angles, and two large spots on the disc, extending to the posterior margin, deep blue-violet: scutellum thickly and finely punctured, slightly wrinkled transversely at the base; with a spot in each basal angle, a large, irregular, transverse patch in the middle of the base, and a transverse row of four spots of which the two intermediate are by much the largest, across the disc, behind the middle, deep blue-violet; the surface around all the spots clouded with orange-red: margins of hemelytra, black: abdomen beneath red, immaculate, thickly and finely punctured, and slightly pilose, with a strong median furrow at the base: anal apparatus reddish: pectus thickly punctured, yellowish, variegated with blackish violet, the prostethium pale red, with a violet-black spot at the base of the anterior legs: femora testaceous, [sometimes violet-black] their apices with the tibiæ and tarsi shining violet-black: head beneath yellowish in the middle, with its margins violet: antennæ black, the two basal joints with a violet tinge: rostrum testaceous with the two last joints black, the tip reaching the base of the fourth ventral segment. In some the fine spots in the middle of the base of the scutellum are confluent but normally they are as in *P. Druræi*, Dallas. Body, long 19-21 mill.

Reported from China, Assam. The Indian Museum has specimens from Assam. The variety with the five spots at the base of the scutellum confluent agrees with *P. donovani*, Burm. in this particular, and also in the absence of the two subapical spots and the length of the rostrum, but differs in form and general colouring.

64. PŒCILOCORIS ORNATUS, Dallas.

Pœcilocoris ornatus, Dallas, List Hem. i, p. 15 (1851); Walker, Cat. Het. i, p. 9 (1867).

Pœcilochroma ornata, Stål, En. Hem. iii, p. 12 (1873): Scott, A. M. N. H. (4 s.) xiv, p. 289 (1874).

Above orange-yellow, finely punctured with black: head rather short, the tylus considerably longer than the juga, with the apex slightly turned up; vertex black, with three rows of golden green punctures of which the lateral are broadest, and include the ocelli; front of head, deep red, punctured with violet and green; the apex orange: thorax with the anterior and lateral margins and two large spots on the posterior margin, black, leaving only a narrow transverse band and a longitudinal median line, orange; scutellum with fine confluent black spots on the basal half, forming a broad, irregular W; four others across the middle, united in pairs; forming a band interrupted in the middle, and two close to the apex; all the black spots are tinted with violet and brassy green; abdomen beneath ochroous, very finely punctured, with a large strongly punctured golden-green spot, on each side of every segment; ventral furrow reaching the apex of the fifth segment; pectus testaceous, variegated with golden-green: femora of the same colour with golden-green reflections; tibiæ brown, slightly metallic; tarsi piceous: rostrum yellowish-brown, with the tip black, reaching the middle of the fourth ventral segment: antennæ violet black; basal joint orange-black at the tip (*Dallas*). Long 15—15½ mill.

Reported from N. India, Japan.

65. PŒCILOCORIS DRURÆI, Linn.

Cimex druræi, Linn., Mant. Pl. ii, p. 534 (1771): Drury, Ill. Ins. i, p. 94, t. 42, f. 1 & 5, a, b (1770): Sulzer, Gesch. i, p. 95, t. 10, f. 5 (1776): Fabr., Syst. Ent. p. 697 (1775): Spec. Ins. ii, p. 339 (1781); Mant. Ins. ii, p. 281 (1787); Ent. Syst. iv, p. 83 (1794); Gmelin ed. Syst. Nat. i (4), p. 2129 (1788): Stoll, Punaises, p. 147, t. 37, f. 267 (1788). India.

Tetyra druræi, Fabr. Syst. Rhyng. p. 132 (1803): Burm. Nov. Acta Leop. xvi, Suppt. i, p. 287 (1834).

Scutellera druræi, Germar, Zeitschr. i (i), p. 135 (1839).

Pœcilocoris druræi, Dallas, Trans. Ent. Soc. v, p. 103, t. 13, f. 6 (1848); List Hem. i, p. 12 (1851): Walker, Cat. Het. i, p. 8 (1867).

Pœcilochroma druræi, Stål, En. Hem. iii, p. 12 (1873); Distant, A. M. N. H. (5 s.) iii, p. 44 (1879).

Scarlet: head and antennæ black; antennæ 5-jointed, a little longer than the thorax, the two first joints, shortest: thorax convex, the lateral margins slightly reflexed, two suboval spots which form an obtuse angle with the head and are truncated on the sides, black:

scutellum with two black bands formed of confluent spots [not always confluent], the basal allowing two scarlet spots to be seen, that just below the middle, irregularly indented on both sides and two round black spots at the apex: hemelytra opaque, membrane fine and with the wings semi-transparent: abdomen beneath scarlet, with an oblong black spot at the anus, and four others on each side reaching the margin: pectus, rostrum and legs blue-black *(Drury).* Long 18 mill.

Dallas remarks that the normal condition of this species exhibits the typical colouring of the genus: in it the spots on the scutellum are arranged,—five basal, of which the median one is somewhat triangular and rather short, the two intermediate smallest; two behind these, placed opposite the intermedial basal ones, a row of four across the disc, rather behind the middle and two towards the apex: the seven spots at the base are frequently confluent, forming a large basal patch with three large notches in its posterior margin (as in Drury's figure); the row of spots across the disc is also often united to form a transverse band. The narrow basal segment of the abdomen and generally the second segment also, are violet-black; the stigmata of the other segments are surrounded by spots of the same colour which generally occupy the entire lateral margins of the segments and thus form a black border to the abdomen; the terminal segment, except the posterior and lateral margins, is black.

Reported from Hong-Kong, Silhat, Assam: the Indian Museum possesses specimens from Sikkim and Assam.

66. PŒCILOCRIS OBSOLETUS, Dallas.

Pœcilororis obsoletus, Dallas, Trans. Ent. Soc. v, p. 104 (1848); List Hem. i, p. 12 (1851); Walker, Cat. Het. i, p. 8 (1867).

♂. Ovate, above bright velvety-red, thickly punctured: head and eyes, black; ocelli reddish: thorax with the anterior and lateral margins smooth, shining, rather coarsely and irregularly punctured; two indistinct yellowish patches within the anterior angles, and faint indications of two elongated violet spots on the disc: scutellum slightly wrinkled transversely at the base, and with indications of eleven violet spots, placed five at the base, two behind these, and four in a transverse row across the middle; the apical portion orange, finely reticulated with red; margins of hemelytra bright red, thickly and coarsely punctured: abdomen red, shining, with a few scattered punctures, and a faint longitudinal furrow at the base; the basal segment pitchy black, a small spot around each of the stigmata, and a large crescent-shaped one, on the terminal segment, black: anal apparatus red: pectus violet-black, shining, finely and sparingly punctured, a dull space on each side of the meso- and meta-stethium; the antero-lateral margins and the lateral angles red: femora brownish, slightly tinted brassy, their apices, the tibiæ and tarsi, brassy black; head beneath shining violet, punctured, yellowish at the base: antennæ black, the three basal joints tinted with violet and brassy, the two apical covered with short greyish hairs; rostrum pitchy *(Dallas)*. Long, 19 mill.

Reported from Hong-Kong: I possess specimens from Assam and Sikkim. Dr. Stål united this species with *P. druræi*, and, although the indications of spots are arranged in exactly the same manner as in *P. druræi*, the two subapical ones are generally wanting, whilst the red colour of the margins of the hemelytra, the colour of the legs, the peculiar texture of the margins of the thorax, and the clothing of the two last joints of the antennæ, mark it as a distinct species. In some, beneath, the colouring is exactly as in the preceding, whilst, in others, the pectus and venter are entirely brassy green, and only the anal apparatus and the antero-lateral and lateral margins of the pectus are red.

67. PŒCILOCORIS INTERRUPTUS, Westwood.

Tectocoris interrupta, Westwood, Hope, Cat. Hem. i, p. 14 (1837).

Scutellera interrupta, Germar, Zeitschr. i (i), p. 134 (1839): Herr. Schäff., Wanz. Ins. v, p. 73, t. 172, f. 531 (1839).

Pæcilocoris interruptus, Dallas, Trans. Ent. Soc. v, p. 102 (1848): List Hem. i, p. 12 (1851); Walker, Cat. Het. i. p. 8 (1867).

Pæcilochroma interrupta, Stål, En. Hem. iii, p. 13 (1873).

Broadly ovate, rather flat; above brassy black, thickly and finely punctured: eyes pale brown, ocelli red: pronotum with the posterior margin and a curved longitudinal line on each side, within the lateral angles, bright [orange] red: scutellum with a narrow, transverse line on the disc near the middle, interrupted in the middle, and the apical margin, bright [orange] red: margins of hemelytra brassy black, of the abdomen black, variegated with bright red; abdomen beneath, black, shining, slightly brassy, the bases of 2-5 segments in the middle, and a marginal spot on the junction of each segment, red: anal aparatus, black, margined with red in the ♀: pectus brassy black, thickly and finely punctured: antennæ, rostrum and legs, black *(Dallas)*. Dallas remarks that in a long series of this insect there is no indication of distinct spots, but it is probable that the anterior margin and two spots on the disc of the pronotum are black, and that the spots on the scutellum are arranged much as in *P. hardwickii*. Body long 15-19 mill.

Reported from Nepál, India. The Indian Museum has a specimen.

68. PŒCILOCORIS PURPURASCENS, Westwood.

Tectocoris purpurascens, Westwood, Hope, Cat. i, p. 14 (1837).
Scutellera purpurascens, Germar, Zeitschr. i. (i), p. 135 (1839).
Pœcilocoris purpurascens, Dallas, Trans. Ent. Soc. v, p. 103, t. 13, f. 5 (1848); List Hem. i, p. 13 (1851): Walker, Cat. Het. i. p. 8 (1867).
Pœcilochroma purpurascens, Stål, En. Hem. iii, p. 13 (1873).

♂, ♀. Ovate; above variegated with violet and black, thickly and strongly punctured: head nearly smooth, shining, slightly wrinkled and punctured at the base and the apex; eyes and ocelli brown: pronotum with a small red spot in the middle of the anterior margin, a corresponding one on the posterior margin and a small streak of the same colour on each side towards the lateral angles: scutellum with a small transverse streak on each side before the middle, a smaller longitudinal one towards the apex and an oblique one on each side of this, on the lateral margins, bright red: margins of hemelytra violet-black: abdomen beneath slightly wrinkled, shining brassy-green, the margins violet with an irregular, transverse, red streak on each side of the 2-5 segments: anal apparatus brassy black: pectus violet and green, shining, finely punctured, with a dull black patch on the meso- and meta-stethium: legs violet-black: head beneath violet and green, shining, punctured: antennæ and rostrum, black *(Dallas)*. Dallas observes that the normal arrangement of the spots (indicated by the strong violet tints on various parts of the surface) is the same as in *P. druræi*. Body long 17—19 mill.

Reported from Nepál, Sikkim.

69. PŒCILOCORIS PULCHER, Dallas.

Pœcilocoris pulcher, Dallas, Trans. Ent. Soc. v, p. 105, t. 13, f. 7 (1848): List Hem. i, p. 13 (1851): Vollenhoven, Faune Ent. l'Arch. Indo-Néer. i, p. 5, t. 1, f. 2, 2a, (1863); Walker, Cat. Het. i. p. 8 (1867).
Pœcilochroma pulchra, Stål, En. Hem. iii, p. 13 (1873).

♂ Ovate, deep velvety purple, closely and finely punctured: head above of a vinaceous purple, below violet and green, shining, orange at the base, with four longitudinal impressions along the tylus and two oblique dotted hollows at the inner side of the eyes, blackish along the margins of the lobes: eyes brownish, ocelli small, reddish: 1-2 joints of antennæ violet, smooth, rest black, pubescent: pronotum broadly margined with red laterally and anteriorly, and with a narrow, median longitudinal line of the same colour, on the disc, reaching the posterior border: scutellum deep purple with the base (irregularly), a transverse band across the disc before the middle, and a narrow median line uniting these one to the other, also a small spot on each side of the latter (sometimes wanting), shining violaceous: margins of the hemelytra brownish purple: abdomen with a strong furrow at the base, bright red, with a violet reflection, smooth, shining, very finely and moderately punctured; a black spot around each of the stigmata and a faint band of the same colour across the terminal segment: anal plate red: pectus purple variegated with violet and greenish tints, shining, thickly and finely punctured, the antero-lateral margins and lateral angles, red: femora brassy purple; tibiæ, shining violet; tarsi black: rostrum brassy black, basal joint pale pinkish violet. Spots as in *P. druræi* except that the two subapical ones are wanting, others easily traced in the violet tints of the base, and the broad band across the middle of the scutellum. (*Dallas*). Body long 18-19 mill.

Reported from Malabar, Sumatra.

70. PŒCILOCORIS CHILDRENI, White.

Tectocoris childreni, White, Charlesworth Mag. N. H. iii, p. 542 (1839).

Tectocoris (*Pœcilochroma*) *childreni*, White, Trans. Ent. Soc. iii, p. 84, t. 7, f. 1 (1838).

Pœcilocoris childreni, Dallas, Trans. Ent. Soc. v, p. 106 (1848); List Hom. i, p. 13 (1851): Walker, Cat. Het. i, p. 8 (1867).

Pœcilochroma childreni, Stål, iii, p. 13 (1873).

Head (including eyes, antennæ, and rostrum) black, distinctly margined; ocelli yellow: thorax and scutellum yellowish-fulvous, the former in front black, the black colour extending in a narrow line along the slightly raised lateral margin, with four transverse black spots, the two dorsal ones larger and rather quadrate: legs green: scutellum obtuse, with eleven black spots, three at the base, the median one triangular and largest, two behind these sub-rotundate, four in the middle (the two inner largest) and two near the tip: hemelytra black, somewhat shining: body beneath, purplish black, sides of abdomen with four transverse yellow lines, sometimes confluent at the base and forming a yellow patch, end of abdomen green (*White*). Long, 18; breadth of pronotum, 11 mill.

Reported from Nepál, Sikkim.

The spots on the scutellum are placed,—three basal, of which the median one is large, triangular and produced on each side at the base, in such a manner that it appears as though in the normal state there would be an additional spot on each side, as in *P. druræi;* two behind these, a row of four across the disc, rather behind the middle and two subapical. Distinguished from *P. druræi* by the broad, black anterior margin of the pronotum and the black anal plates: from *P. hardwickii* by the margins of all the segments of the abdomen being violet-black and from both, by the presence of four spots on the disc of the pronotum and by the entire pectus being violet-black. It is possible that in the normal condition the disc of the abdomen may be yellow or orange margined with black *(Dallas)*.

71. PŒCILOCORIS OBESUS, Dallas.

Pœcilocoris obesus, Dallas, List Hem. i, p. 13 (1851); Walker, Cat. Het. i, p. 9 (1867).

Pœcilochroma obesa, Stål, En. Hem. iii, p 13 (1873).

Convex, rather short: above bright red, shining, very finely and rather sparingly punctured, with the head, the fore-part of the thorax and three or more less distinct spots at the base of the scutellum, brassy green: thorax slightly excavated on the anterior margin, the impression strongly punctured and with a strong impression about the middle of each antero-lateral margin: body beneath, antennæ and legs bright brassy green; the antero-lateral margins of the pectus and a spot in the middle of the abdomen, red: rostrum black, reaching the middle of the third segment of the abdomen *(Dallas)*. Body, long 13½-14¾ mill.

Reported from Assam, N. India.

72. PŒCILOCORIS RUFIGENIS, Dallas.

Pœcilocoris rufigenis, Dallas, List Hem. i, p. 14 (1851); Walker, Cat. Het. i, p. 9 (1867).

Pœcilochroma rufigenis, Stål, En. Hem, iii, p. 13 (1873).

Above orange-yellow with violet reflections, thickly and finely punctured: head purplish red with the base and the whole of the tylus black: thorax with the anterior and lateral margins violet and with a black spot within each anterior angle: scutellum with a narrow black band across the base and a black triangular spot on each side before the middle, touching the lateral margin, its base faintly wrinkled; basal angles strongly rugosely-punctate: margins of hemelytra, black: abdomen beneath and anal plate reddish orange tinted with violet, smooth, shining, very faintly punctured, the terminal segment violet-black, except its margins and a transverse streak of the same colour on each side of the rest of the segments, except the basal one: ventral furrow distinct, reaching apex of the fifth segment: breast shining violet, with the antero-lateral margins, red: legs brassy black: rostrum black, reaching the base of the terminal segment of the abdomen: head, beneath red; with the rostral canal violet-black: antennæ black *(Dallas)*. Long, 19 mill.

Reported from Assam.

73. PŒCILOCORIS ANISOSPILUS, Walker.

Pœcilocoris anisospilus, Walker, Cat. Het. i, p. 9 (1867).

Black: head smooth, with a punctured furrow on each side between the eyes, and with another on each side in front: thorax bright red, with a black spot on each side on the disc and with a smooth black band along the anterior margin which is largely punctured: pectus with a lanceolate red streak along each side: scutellum bright red, with three bands of black marks: the first band of five spots of which the median is large and triangular reaching the fore border, the inner pair are small and isolated, the outer pair large and lateral and touching the anterior margin: of the second band of four black spots, the inner pair are large, the outer pair, small and lateral; the third band is composed of two black points: abdomen beneath red, black at the base and at the tip *(Walker)*. Rather shorter than *P. dives*, Guérin; differs in the markings on the thorax and scutellum and the abdomen beneath has no black spots on each side. Possibly only a small variety of *P. ornatus*, Dallas. Long, 13 mill.

Reported from Cachar (Assam).

Genus TETRARTHIA, Dallas.

List Hem. i, p. 3, 20 (1851): Stål, Hem. Afric. i, p. 33 (1864); En. Hem. iii, p. 8, 13 (1873): Mayr, Reise Nov. Hem. p. 12 (1866): Walker, Cat. Het. i, p. 18 (1867).

Body elongate, sericeous: head rather long, convex, especially anteriorly, lateral margins somewhat acute before the middle and sinuated, no longitudinal impression near the eyes, tylus longer than the juga: rostrum long, reaching the posterior margin of the fourth ventral segment, first joint very short, second and fourth about equal in length, twice as long as the first, second joint compressed, third longest, about equal in length to the first and second taken together; antennæ 4-jointed, second joint about thrice longer than the basal joint which does not reach the apex of the head: posterior angles of thorax obtusely rounded, entire anterior margin of the propleura obtuse, elevated, posterior margin straight at the angles: scutellum rounded at the apex, covering nearly the whole of the hemelytra: venter with a long furrow, sides flattish, anteriorly somewhat convex, posterior margin of segments straight on both sides, the furrow of the orifices long, straight or very slightly curved, abruptly produced forwards at the apex or emitting forwards a wrinkle or ridge: pectus without a furrow for the reception of the rostrum or projecting flaps covering the base of the antennæ; legs moderate: tarsi 3-jointed, second joint shortest *(Dallas)*.

74. TETRARTHIA LINEATA, Walker.

Tetrarthia lineata, Walker, Cat. Het. i, p. 18 (1867).

Ferruginous-red, fusiform, bright-red beneath: four stripes on the head and beneath on both sides, five stripes on thorax, of which the outer pair are oblique, its anterior and lateral margins, a dot on each side of the anterior margin of the scutellum and two oblique streaks which converge hindward and a broad stripe on each side of pectus, emerald-green: antennæ piceous, fourth joint pale yellowish towards the base: scutellum with a luteous dot on each side at two-thirds of the length: abdomen beneath with two rows of black spots on each side and with a black subapical patch: legs pubescent; tibiæ and tarsi above and femora towards their tips tinged with green: wings brown: costa of the corium purple. Var.? No emerald-green markings: head bluish-black: thorax bluish-black in front and on each side: scutellum with no luteous dot: pectus blackish *(Walker)*. Long, 14¾ mill.

Reported from Hong-Kong; variety from Burma.

75. TETRARTHRIA VARIEGATA, Dallas.

Tetrarthria variegata, Dallas, List Hom. i, p. 20, t. 1, f. 1 (1851); Stål, Ofvers. K. V.-A. Förh. p. 616 (1870); En. Hem. iii, p. 14 (1873).

Tetrathria margine-punctata, Vollenhoven, Faune Ent. l'Arch. Indo-Néer. p. 13, t. 1, f. 6 a-b (1863); Walker, Cat. Het. iii, p. 508 (1868).

Tetrathria quinquemaculata, A. Dohrn, Stettin Ent. Zeit. xxiv, p. 347 (1863).

Head black, with some scattered, coarse punctures, the lateral margins and two parallel longitudinal lines brassy-green; eyes pale brown; thorax with a large, semicircular brassy green patch on the disc, touching the posterior margin, and surrounded by a broad dull red band which runs from one posterior angle to the other; four spots on the disc, near the posterior margin, of which the two intermediate are largest, and the anterior and lateral margins black: scutellum brassy green in the middle, the margins dull red, punctured and thickly clothed with fine golden hairs, with a large black patch in the middle of the base, two small spots of the same colour immediately behind this, and two large ones on the lateral margins immediately behind the middle; a large T-shaped black patch occupies the disc of the scutellum, formed by a transverse band, before the middle, and a median longitudinal one which reaches nearly to the apex, and is furcate posteriorly: abdomen beneath red, with broad black margins: rostrum red: legs black with the basal half of the femora bright red: antennæ black with the basal joint reddish and a pale band near the base of the fourth joint *(Dallas)*. Varies in having the scutellum and thorax rufous-testaceous: anal segment in ♂ truncate at apex; finely erosulous and in the middle with a somewhat prominent tooth. Long, 16¾ mill.

Walker remarked that *T. margine-punctata*, Voll. was probably only a variety of *T. variegata*, Dallas ; and it is now recognized as such. The type of this variety has the borders of the body above and the entire body below covered with a grey villosity ; head a little punctured, with a glossy chocolate-brown line in the middle ; two longitudinal lines and the border of the eyes, golden-green ; antennæ pale brown, pubescent ; base of fourth joint whitish : eyes brown, ocelli yellow : pronotum punctured, with a row of deep dots on the anterior border, preceding a transverse glossy space which is of a chocolate-brown, the border being golden-green : disc of pronotum and scutellum purplish black with several obscure metallic-blue lines : border surrounded by a row of yellow triangular patches : body beneath yellow with some golden-green lines on the head and pectus : ventral borders marbled with brown ; 5th and 6th segments altogether brown ; rostrum pale yellow, with the tip obscure : coxæ and half of femora of a pale yellow, other half deep brown : tibiæ and tarsi, yellowish brown. Long, 15 mill. A Silhat specimen is paler and has the border of the scutellum interrupted at the tip.

Reported from Phillipines, Java, Tondano, Celebes, Silhat. The Indian Museum possesses specimens from Sibságar (Assam).

Genus SCUTELLERA, Lamarck.

Syst. p. 293 (1801) : Dallas, List Hem. i, p. 4, 18 (1851) : Walker, Cat. Het. i, p. 15 (1867) : Stål, Hem. Afric. i, p. 33 (1864) ; En. Hem. iii, p. 9, 14 (1873) : Mayr, Reise Nov. Hem, p. 17 (1866). Includes *Calliphara*, Am. & Serv. Hist. Nat. Ins. Hém. p. 30 (1843), nec Germar.

Body subsericeous or pilosulous, very oblong : head triangular, obtuse, sloped : rostrum extending beyond the second ventral segment : antennæ 5-jointed, second joint not or only a little shorter than the first, fourth the longest : pronotum with a transverse linear impression before the middle, generally strongly punctured, the base distinctly truncated, posterior angles distinct, posterior margin of propleura generally distinctly sinuated at the angles, anterior margin obtuse, thickened, slightly amplified near the prosternum : the meso-sternum furrowed : venter furrowed beyond the middle ; the furrow of the orifices very long, gradually curved forwards towards the apex, the part of the metapleura situate before the furrow, smooth, shining : feet rather long.

76. SCUTELLERA NOBILIS, Fabricius.

Cimex nobilis, Fabr. (nec Linn.), Syst. Ent. p. 697 (1775) ; Spec. Ins. ii, p. 338 (1781) ; Mant. Ins. ii, p. 280 (1787) ; Ent. Syst. iv, p. 80 (1794) : Gmelin, ed. Syst. Nat. i (4) p. 2128 (1788) ; Panzer in Voet, Col. iv, p. iii, t. 47, f. 1 (1798) ; Wolff, Ic. Cim. ii, p. 49, t. 5, f. 46 *a-d*, (1801) : Stoll, Punaises, p. 8, t. 1, f. 1 ; p. 13, t. 2, f. 7, and p. 20, t. 4, f. 22, 23 (1788).

Tetyra nobilis, Fabr., Syst. Rhyng. p. 129 (1803).

Tectocoris nobilis, Hahn, Wanz. Ins. iii, p. 24, t. 81, f. 247 (1835).

Tectocoris perplexa, Westwood, Hope, Cat. Hem. 1, p. 4 and 15 (1837).

Calliphara nobilis, Germar, Zeitschr. i, (i) p. 124 (1839): Am. & Serv. Hist. Nat. Ins. Hém. p. 30 (1843).

Scutellera nobilis, Lam. Hist. Nat. iii, p. 491 (1816) : Burm. Handb. ii, (i) p. 395 (1835); Blanchard, Hist. Nat. Ins. iii, p. 158, Hèm. t. 8, f. 3 (1840); Dallas, List Hem. i, p. 18 (1851); Walker, Cat. Het. i, p. 15 (1867); Vollenhoven, Faune Ent. l'Arch. Indo-Néer. p. 11 (1863); Stål, En. Hem. iii, p. 14 (1873); Distant, A. M. N. H. (5 s.) iii, p. 44 (1879).

Oblong; cærulean-golden, spotted black: beneath rufous, with lateral bands shining blue and gold (*C. nobilis*, Fabr.).

Light metallic green, varying to deep blue or even purple: body above and beneath and legs covered with a fine greyish pubescence more abundant on the head and anterior part of pronotum, abdomen and legs: eyes brown, ocelli red: rostrum reddish or brown: first joint of antennæ reddish brown, rest black: pronotum with a deep transverse groove anteriorly, a row of excavated points on anterior margin, lateral margins reddish brown, three irregular spots towards anterior margin, a median longitudinal line, a spot on each side thereof and on the humeral angles, black: scutellum with a median longitudinal line reaching to about the middle and three spots on each side thereof, black, a smaller sublateral spot on each side between the second and third pairs, sometimes also a sublateral spot between the first and second pairs, and sometimes all or some are more or less obsolete: body beneath red with a purplish tint; head beneath, patches on pectus, and oblique transverse bands on abdominal segments, interrupted in the middle and not reaching the margins, golden blue or green: coxæ and femora red, tips of femora, tibiæ and tarsi deep metallic violet. Varies much in size from 14 to 21 mill.

Var.:—Head green with three black spots: first joint of the antennæ black not red: lateral margins of pronotum without a red limbus, first third green, rest blue with traces of five black spots; scutellum blue with ten black spots: abdomen beneath golden green, shining, with a large orange yellow patch on the disc, margin orange, crenulated black: anal plate green (*Voll.*).

Reported from Bengal, Pondicheri, Assam (Silhat, Cachar), Burma, Panjab, India, Siam. The Indian Museum possesses specimens from N. India, S. India, Karachi, Sikkim, Assam, and Calcutta.

77. SCUTELLERA FASCIATA, Panzer.

Cimex fasciatus, Panzer, in Voet, Col. iv, p. 108, t. 46, f. 2 (1798): Stoll, Punaises, p. 138, t. 36, f. 251; var. p. 34; t. 7, f. 49 (1788).

Tectocoris nepalensis, Westwood, Hope, Cat. Hem. 1. p. 14 (1837).

Calliphara nepalensis, Germar, Zeitschr. i (i) p. 125 (1839).

Calliphara amethystina, Germar, Zeitschr. i (i) p. 124 (1839).

Scutellera amethystina, Vollenhoven, Faune Ent. l'Arch. Indo-Néer. i, p. 12 (1863): Walker, Cat. Het. iii, p. 507 (1868).

Callidea lanius, Stål, Ofvers. K. V.-A. Förh. p. 231 (1854).

Scutellera lanius, Stål, l. c. p. 51 (1856): Walker, l. c. i, p. 15 (1867).

Scutellera fasciata, Dallas, List Hom. i, p. 19 (1851); Walker, l. c. i, p. 15 (1867); Stål, En. Hem. iii, p. 14 (1873).

Body fusiform; pilose on the head; first third of pronotum, body beneath and feet, purple: head wrinkled only on the margins, beneath and two first joints of the antennæ, violet: eyes brown, ocelli red: rostrum, half red, rest black: pronotum deeply grooved and with a row of excavations on the anterior margin, lateral margins greenish or golden; two spots at the anterior angles and four near the base brown or blackish: scutellum with three bands, often interrupted (especially the first), and two small lateral and one large median spot of the same colour, all of them are sometimes more or less obsolete: body beneath red, pectus with several violet spots, venter with two rows of oblique spots, alternately violet and golden: stigmata black: coxæ and femora red: tips of femora, tibiæ and tarsi, deep violet. (*S. amethystina*, Voll.). Body long 18-20 mill.

Westwood describes his *T. nepalensis* as cærulean-green, clypeus golden, head with a median line and two oblique spots between the eyes, black; sides of thorax golden-yellow; dorsum with three interrupted longitudinal lateral lines; scutellum with two round spots at the base, a broad waved band before the middle, two round lateral spots and two others much larger and confluent beyond the middle, and the apex, black. Long 19 mill. Stål makes his *S. lanius* from Java a variety marked by its greater size, more robust, subsanguineous above, slightly shining violaceous, spots unicolorous without the violaceous tinge. Long, 22; broad 9 mill.

Reported from Java, Borneo, Malacca, China, Burma, Assam, Nepál, Sikkim.

Genus Brachyaulax, Stål.

Ofvers. K. V.-A. Förh. p. 616 (1870); En. Hem. iii, p. 9, 14 (1873).

Body very oblong, above slightly, beneath very convex, briefly pilose, shining: head triangular, somewhat convex, sides very convex before the eyes, lateral margins sinuate towards the base, rounded towards the apex; bucculæ continuing through it, slightly elevated: ocelli twice more distant from each other than from the eyes: rostrum extending to somewhat behind the last coxæ: antennæ shorter by half than the body, first and second joints short, the latter extending to the apex of the head and a little shorter than the first, third somewhat longer than the two basal together, fourth and fifth longer than the rest, fourth especially compressed, dilated: thorax sexangular, anteriorly truncated, distinctly transversely impressed before the middle, anterior lateral margins, obtusely sinuated, obtuse: scutellum covering the entire abdomen: prostethium triangularly impressed, margins of impression elevated, subdilated: mesostethium obtusely sulcate: odoriferous apertures continued outwards in an elongated furrow, slightly curved and abruptly abbreviated: sides of venter very convex, incisures gradually curved second segment broadly sulcate in the middle: feet moderate, tibiæ distinctly sulcate above. Differs from *Scutellera,* Lam. in having the furrow of the odoriferous apertures shorter, less curved, and the venter furrowed only at the base *(Stål).*

78. BRACHYAULAX OBLONGA, Westwood.

Tectocoris oblonga, Westwood, Hope, Cat. i, p. 14 (1837).

Calliphara oblonga, Germar, Zeitschr. i (i) p. 129 (1839).

Scutellera oblonga, Dallas, List Hem. i, p. 19 (1851); Walker, Cat. Het. i, p. 15 (1867).

Brachyaulax oblonga, Stål, En. Hem. iii, p. 14 (1873); Distant, A. M. N. H. (5 s.) iii, p. 44 (1879).

Ovate-oblong, metallic bluish-green; head with three spots between the eyes; thorax with six, three by three, the posterior larger; scutellum with three small basal, two larger rounded, two lateral small, two behind the middle, rounded, large, and one sub-apical spot, or ten in all: body beneath cærulean-green, base of the abdomen in the middle and the sides irregularly fulvous; antennæ black, feet green *(Westw.).* Body long, 13¼ mill.

Reported from Java, Assam, China. The Indian Museum has a specimen from Assam which differs from the type in having the large median spots on the scutellum confluent, forming two waved transverse bands (*Dist.*) and in some these are connected by a median, longitudinal arrow-shaped mark.

Genus CALLIPHARA, Germar.

Calliphara, pt, Germar, Zeitschr. i (i) p. 122 (1839): Stål, En. Hem. iii, p. 9, 16 (1873). Includes *Calliphara,* Stål, Hem. Afric. i, p. 34 (1864) and *Lamprophara,* l. c. p. 34 (1864).

Stål distributes the species belonging to this genus amongst the subgenera *Lamprophara, Calliphara* and *Chrysophara* to none of which does he assign the only species recorded from India. The third joint of the antennæ is over twice as long as the second: rostrum reaching at least the middle of the second ventral segment: the ventral segments (at least the last and the penultimate) furnished at the apical angles with a small tooth or spine which is sometimes covered by the hemelytra and then with difficulty distinguished: the scutellum does not cover the exterior margin of the connexivum *(Stål)*.

79. CALLIPHARA OBSCURA, Westwood.

Tectocoris obscura, Westwood, Hope, Cat. i, p. 14 (1837).
Calliphara obscura, Stål, En. Hem. iii, p. 18 (1873).

Head and pronotum black-cœrulean; the latter with three posterior spots; scutellum green, with seven spots (two, two subconfluent, two rounded beyond the middle, and one small, subapical); body beneath, black-cœrulean, venter green, with black lateral spots; femora luteous at the base. Body, long $17\frac{3}{4}$ millims.

Reported from Nepál. Stål inquires 'an potius Insulæ Philippinæ.'

80. CALLIPHARA NOBILIS, Linnæus.

Cimex nobilis, Linn., Cent. Ins. i, p. 17 (1763); Amæn. Ac. vi, p. 400 (1763).
Cimex pustulatus, Panzer in Voet, Coll. iv, p. 111, t. 47, f. 11 (1798).
Scutellera Buquetii, Guérin, Voy. Coq. Ins. ii (2), p. 159, 162 (1830).
Callidea nobilis, Dallas, List Hem. i, p. 25 (1851); Walker, Cat. Het. i, p. 32 (1867).
Calliphara buquetii, Stål, Berlin Ent. Zeitschr. x, p. 153 (1866); Ofvers. K V.-A, Förh. p. 618 (1870).
Calliphara nobilis, Stål, En. Hem. iii, p. 17 (1873).

Above light green, shining, in some specimens with violet reflections: head rather small, triangular; eyes brown very prominent; in the middle, a small smooth green elevation, a little dilated hindward and bounded by two small grooves: antennæ in ♂, nearly half the length of the head, in ♀ a little shorter, black, with the joints flattened: thorax almost straight or only a little emarginate on the sides, punctured; on each side in front an impression, black at the bottom, placed obliquely, and four small round black spots, a little beyond the middle; in some specimens there is an oblong red spot between the two anterior impressions, in others there are only two spots on the sides: scutellum slightly grooved at the base, much punctured, with a longitudinal line in the middle having no punctures and feebly marked; three small, round, black spots on each side, and a smaller in the middle and near the tip: thorax beneath, red, with large green spots, confluent on the sides; margin red, partly visible above: abdomen vermillion, sides broadly bordered green and on their external margin are four large black dots, and inwards four black patches less well defined, the extreme external margin is red: rostrum black, red at the base: femora red, tips partly green; tibiæ and tarsi deep green (*S. buquetii*, Guérin). Long, 16—17; broad, 8—8½ mill. at base of scutellum.

Reported from Philippines, Java, Timor, China, Burma.

Genus CHRYSOCORIS, Hahn.

Wanz. Ins. ii, p. 38 (1834); White, Trans. Ent. Soc. iii, p. 85 (1841-43); Stål, Hem. Afric. i, p. 34 (1864); En. Hem. iii, p. 9, 18 (1873).

Includes *Callidea*, Am. & Serv. (nec Burm.), Hist. Nat. Ins. Hèm. p. 31 (1843); pt. Dallas, List Hem. i, p. 22 (1850); Walker, Cat. Het. i, p. 25 (1867):—*Eucorysses*, Am. & Serv., l. c. p. 31 (1843); Stål, Hem. Afric. i, p. 34 (1864); Mayr, Reise Nov. Hem. p. 18 (1866):—*Galostha*, Am. & Serv., l. c. p. 32 (1843):—*Cosmocoris*, Stål, Hem. Afric. i, p. 34 (1864); Mayr, Reise Nov. Hem. p. 18 (1866).

Stål distributes the species belonging to this genus amongst the subgenera *Eucorysses*, *Cosmocoris*, and *Chrysocoris*, all of which are represented in India. Differs from *Calliphara* in having the scutellum covering the whole connexivum, except the basal part. Body above glabrous: the third joint of the antennæ at least twice as long as the second: the three last joints of the rostrum unequal in length: lateral margins of the head neither carinated nor reflexed, anterior margin of the prostethium not callous behind the eyes, obtuse: meso-sternum, at least anteriorly, somewhat sulcated, the furrow generally slightly carinated on both sides: posterior margin of the propleura distinctly sinuated at the posterior angles: the ventral segments, at least the last or the penultimate, furnished at the apical angles with a small tooth, often covered by the hemelytra and then difficult to distinguish.

Subg. EUCORYSSES, Am. & Serv.

Head somewhat large, not much inclined, sides not deeply sinuated: anterior lateral margins of pronotum straight or somewhat so: basal part of the scutellum not, or but very obsoletely, elevated: entire tibiæ above furrowed: sixth ventral segment in ♀, as far as known, obtusely or very obtusely angulately prominulous in the middle of the apex.

81. CHRYSOCORIS GRANDIS, Thunberg, Stål.

Eucorysses grandis, Stål, Berlin Ent. Zeitschr. x, p. 154 (1866).

Chrysocoris (Eucorysses) grandis, Stål, En. Hem. iii, p. 18, (1873): Scott, A. M. N. H. (4 s.) xiv, p. 289 (1874): Distant, l. c. (5 s.) iii, p. 44 (1879); J. A. S. Ben. xlviii, (2) p. 37, (1879).

Var. *a*:—*Cimex grandis*, Thunberg, Nov. Ins. Spec. p. 31, t. 2, f. 46 (1783): Gmelin, ed. Syst. Nat. i (4), p. 2133 (1788).

Calliphara grandis, Germar, Zeitschr. i (1), p. 128 (1839).

Callidea grandis, Dallas, List Hem. i, p. 23 (1851): Vollenhoven, Faune Ent: l'Arch. Indo-Néerl. p. 18 (1863): Walker, Cat. Het. i, p. 32 (1867).

Eucorysses superbus, Uhler, Proc. Ac. Nat. Sci. Phil. p. 221 (1860).

Callidea distinguenda, Uhler, l. c. p. 286 (1861).

Var. *b* :—*Cimex baro*, Fabr., Ent. Syst. Suppt. p. 528 (1798).

Tetyra baro, Fabr., Syst. Rhyng. p. 129 (1803); Schiödte in Kröyer's Nat. Tidsskr. iv, p. 279 (1842).

Calliphara baro, Germar, Zeitschr. i (1) p. 127 (1839).

Callidea baro, Dallas, List Hem. i, p. 22 (1851): Walker, Cat. Het. i, p. 26 (1867).

Tetrarthia tetraspila, Walker, l. c. i, p. 19 (1867).

Var. *c.* :—*Eucorysses pallens*, Am. & Serv. Hist. Nat. Ins. Hém. p. 31, t. 1, f. 4 (1843).

Callidea baro, Vollenhoven, l. c. p. 17 (1863).

Head and spots on pectus at the coxæ, flavescent, the head sometimes shining purplish, median streak and basal intraocular part, black: rostrum reaching the middle of the third ventral segment.

Var. *a.* Large, elongate, tumid, glossy, violet beneath, sanguineous above with black spots: head blue with the median line and antennæ black: pronotum sanguineous, much swollen, the anterior margin fringed with violet, at the base, black: a dot on each side behind the anterior angle and a large spot on the disc, black: scutellum sanguineous, the black of the pronotum appears to extend over the base; five black spots on the scutellum one rounded on the median line near the base, two others costal appearing like a band interrupted in the middle, another forms a band abbreviated on two sides and the fifth is near the anal margin: a sanguineous spot sometimes occurs in the middle of the venter: feet black (*Cimex grandis*, Thunb.). Body long, 25 mill.

Var. *a.* ♀, sec. Stål:—Black, thorax, scutellum, spots on pectus at coxæ and transverse median spot on 4—5 ventral segments, yellow-testaceous: margins of thorax and of scutellum shining-violaceous: entire narrow margin, discoidal spot and lateral angles of thorax, basal limbus, spot near base, lateral transverse spot on both sides before middle, abbreviated band behind middle and obsolete subapical spot on scutellum, black: spot on basal angles of ventral segments, yellow-testaceous, much tinted violaceous.

Var. *b.*:—Body large: head pale; antennæ, median line and margin black-cyaneous: thorax pale, shining, with a large ovate spot reaching anterior margin, cyaneous: scutellum large, smooth, pale, shining, with three cyaneous-black spots, the median one cordate: pectus cyaneous: abdomen pale with cyaneous bands: feet cyaneous (*Cimex baro*, Fabr.) Stål describes this variety as flavescent or yellow-testaceous: antennæ, rostrum, anterior spot on thorax, basal limbus and three spots before middle of scutellum, pectus, lateral posterior band on segments, basal streak and apical spot on venter and the feet, black: six spots on the pectus, three at the coxæ and three at the lateral margins, flavescent.

Var. *c.* :— ♂. Pale yellowish, shining above: head with a median longitudinal line and its posterior part, shining black: lateral margins of the pronotum slightly sinuate in the middle, a patch of shiningblack rounded hindwards, touching the anterior margin: two oblong, black, transverse patches on the disc of the scutellum, its base having on each side a similar black spot: body beneath shining black-bluish with transverse lateral bands of a pale shining yellow which unite on the two penultimate ventral segments: anal plate pale shining yellow, feet black metallic-bluish: antennæ black (*E. pallens*, Am. & Serv.). Long, 25 mill.

All these varieties occur in India and are represented in the Indian museum collection. Reported from Japan, China, Siam, Assam, (Silhat), Bengal, Tenasserim, Java.

82. CHRYSOCORIS IRIS, Germar.

Calliphara iris, Germar, Zeitschr. i (i), p. 128 (1839): Herr. Schäff., Wanz. Ins. V, p. 80, t. 171, f. 526 (1839). Bintam.

Callidea sexmaculata, Dallas (nec Leach), List Hem. i, p. 23 (1851); Vollen., Faune Ent. l'Arch. Indo-Néerl., p. 18, t. 1, f. 7 (1863): Walker, Cat. Het. i, p. 31 (1867). Java.

Chrysocoris (Eucorysses) iris, Stål, En. Hem. iii, p. 19 (1873).

Purpurascent, shining violaceous: antennæ and feet black, three spots on thorax also its posterior margin, and six spots on scutellum, black (*Germar*). Schäffer observes that in the example figured by him the ground colour appears to be brown, lighter posteriorly; head, thorax and base of scutellum of a rich violet with rosy red, turning to green on the sides of the thorax and scutellum: feet and antennæ darker. His figure shows anterior and posterior margins of thorax black, a median longitudinal streak proceeding from the anterior margin and posteriorly behind the middle confluent with a short transverse, streak, black: four spots on scutellum joining an arcuate interrupted transverse band before the middle, and two larger oblong transverse spots behind the middle. Long, 24 mill. It is like *C. sexmaculatus*, Leach, but differs in its smaller size, body (especially the head) purpurascent-flavescent, smooth head and shorter rostrum which somewhat reaches the apex of the third ventral segment.

Body above purple with silvery blue reflections: head transversely wrinkled at the apex, vertex of a bronzed blackish green; eyes brown, ocelli brown-yellowish: beneath, the sheath of the rostrum of a metallic green, labrum yellow: antennæ black, second joint one-sixth of the following: thorax punctured, most strongly in the middle of the anterior margin which is of a bronzed green and on the disc, the space between these two is smooth; a cordiform spot on the disc, an abbreviated band along the posterior border and two small spots at the lateral angles, black, these angles slightly, acuminate: scutellum punctured, more strongly at the anterior angle, basal elevation smooth: two bronzed-black spots behind the basal elevation, a black spot at each anterior angle, another pair much larger, almost quadrate behind these near the lateral margin, and a transverse band interrupted in the middle, black; hemelytra black, with the costal margin purple; pectus varied with green, black and red: venter red with purple margins; a large basal spot, a smaller anal spot, an oblique stria on the sides, shining black: feet metallic black, pubescent(*C. sexmaculata*, Voll.). Body long, 24 mill.

Reported from Java, Bintam, Singapore, Tenasserim.

Subg. COSMOCORIS, Stål.

Head somewhat large, not much inclined: pronotum with the anterior lateral margins more or less distinctly sinuated in the middle, furnished in the ♂ anteriorly with a. rather deep triangular impression, scutellum transversely elevated at the base: tibiæ above towards the apex somewhat flat or furrowed.

83. CHRYSOCORIS COXALIS, Stål.

Callidea coxalis, Stål, A. S. E. F. (4 s.) iv, p. 47 (1864): Walker, Cat. Het. i, p. 28 (1867). Tringany.

C. (*Cosmocoris*) *coxalis*, Stål, En. Hem. iii, p. 19 (1873).

♀ Brassy-green, shining, feet more obscure, of the colour of steel: antennæ and rostrum black; a small spot towards the ocelli and a median stripe on the head, five spots on the pronotum and eight on the scutellum, subviolaceous-black; disc brassy-black varying in breadth: coxæ, trochanters and base of femora sordid yellow-whitish. Head moderate, distinctly sinuate before the eyes: second joint of antennæ one-third shorter than basal, the fourth (in ♂ at least) dilated, furrowed; pronotum sparingly and finely punctured, disc before the middle a little more distinctly punctured; antero-lateral margins very slightly sinuate, narrowly and distinctly reflexed, with two anterior transverse spots, one orbicular on each side at the lateral angles, and three large median elongate reaching the base, the median one in the form of a continued stripe, the other two extended forwards beyond the middle of the pronotum: scutellum as broad as the abdomen, not so densely punctured, slightly transversely elevated at the base, there smooth, with eight spots, the subbasal median one formed like the letter T, the rest, transverse, large: sixth ventral segment in ♀, posteriorly obtusely sinuate (*Stål*). Long, 13-15; breadth of pronotum, 7-8 mill.

Reported from Singapore, Tringani, Tenasserim (?).

Subg. Chrysocoris, Hahn.

Head somewhat small, bending much forwards, sides generally strongly sinuated: thorax in ♂ without an anterior triangular impression: basal part of the scutellum not or only slightly elevated: tibiæ above towards the apex flat or furrowed. Stål still further divides this subgenus into the sections *Chlorolampra* including *C. germari*, Esch.; *Chlorochrysa*, including *C. stockerus*, Linn. and *Chrysocoris* including *C. dilaticollis*, Germar.

As the species of this subgenus are not readily distinguishable I adopt the following scheme partly from Stål (Hem. Fabr. i, p. 11) as some help to identification :—

1-2. Venter without any flavescent spot or mark.—*C. atriventris*, mihi.

2-1. Venter with disc, at least, flavescent.

3-17. Lateral margins of pronotum straight or nearly so.

4-16. Pronotum posteriorly with a single black spot in the middle, sometimes wanting, the antero-lateral margins entirely or nearly entirely reflexed.

5-9. Disc of venter flavescent, with four long rays occupying the apical part of the segments, terminated anteriorly inwards by a black transverse spot that reaches the base of the segments and is remote from the black-irised spiracula.

6-8. Ventral limbus cœrulean or brassy-green: posterior margin of pro- and meso-stethium concolorous: femora flavescent beyond the middle.

7-8. Pronotum with ten black or black-cœrulean spots.—*C. elatus*, Stål.

8-6. Ventral limbus, rufescent or purplish, rarely flavescent and purple: posterior margin of parts of pectus, flavescent: femora beyond the middle, miniaceous.—*C. patricius*, Fabr.

9-5. Almost entire venter or a very great part of the disc flavescent, with on both sides short rays that occupy the base and the apex of the segments and are not terminated by a transverse black spot: scutellum typically with the apex black or obscurely violaceous, no sub-apical rounded spot.

10-8. Posterior black spots on the pronotum remote from the base, rather small; ventral limbus brassy-green, or cœrulean, or purplish-violaceous.

11-12. Pronotum with 5 or 7 black spots, that on the lateral angles very small or wanting: femora beyond the middle, flavescent.—*C. purpureus*, Westw. *C. viridis*, mihi.

12-11. Pronotum with 7 or 8 black spots, the anterior median one sometimes wanting, 3 large median posterior spots, reaching the base.—*C. stolii*, Wolff.

13-12. Spots larger and broader, colour more purplish above.—*C. porphyricolus*, Walk.

14-12. Pectus without flavescent spots and lines.—*C. ornatus*, Dallas.

15-12. Scutellum broadly orange at the apex.—*C. andamanensis*, mihi.

16-4. Pronotum with 11 black spots and posteriorly in the middle with 2 oblong spots, antero-lateral margins somewhat acute posteriorly, and a little reflexed.—*C. marginellus*, Westw.; *C. pulchellus*, Westw.

17-3. Lateral margins of anterior part of the thorax, depressed, flat, rounded.—*C. eques*, Fabr.; *C. dilaticollis*, Guérin.

84. CHRYSOCORIS ATRIVENTRIS, Atkinson.

Proc. A. S. B. p. 11, (1887).

Closely allied to *C. hypomelæna*, Voll. from Borneo, differs in the markings on the thorax and in the entire venter being almost wholly deep black. Brassy-green, irrorated golden, shining, closely punctured: head beneath and feet lighter brassy-green, very shining: venter deep black, smooth, slightly shining. Head much inclined, obtusely triangular, rounded at the apex; except the tylus, irrorated golden: eyes, ocelli, antennæ and rostrum, black; 3-5 joints of antennæ somewhat flattened; rostrum reaching almost the apex of the second ventral segment, extremity of tip brownish: thorax with three black spots towards the anterior margin, the lateral subovate-oblong, transverse, impressed, smoothish, the median irregularly triangular, smallest; towards the posterier margin three larger spots, of which the lateral oblong, longitudinal, and the median obtusely triangular, smallest; lateral margins reflexed, a very small black spot on the slightly prominulous posterior angles: scutellum with the basal elevation smooth, shining, and with seven black spots; on each side three lateral, of which the two first are ovate-oblong, transverse, and the third is somewhat rounded posteriorly, also one subbasal median, obtusely-triangular, having its apex pointing hindwards. Head beneath and pectus very bright, shining, brassy-green; antennæ black: entire venter intensely black, smooth, slightly shining; barely traces, under the microscope in the sun, of a slightly purplish limbus and a slightly brassy-green margin to the stigmata: feet blackish, femora tinted brassy-green towards the apex; tibiæ finely ciliated, externally of a blue-steel colour. Long 14; breadth of pronotum, 8 mill.

Example from Delhi.

85. CHRYSOCORIS ELATUS, Stål.

Callidea Stockerus, Germar, Zeitschr. i (i) p. 114 (1839), excl. syn.

Chrysocoris elatus, Stål, Hem. Fabr. i, p. 11 (1868); En. Hem. iii, p. 20 (1873).

Thorax with ten bluish-black or black spots: discoidal spot on scutellum narrow, linear or somewhat so; disc of venter flavescent with four long rays, occupying the apex of the segments and terminated anteriorly inwards by a black transverse spot that reaches the base and apex of the segments, remote from the black-cinctured spiraculan, ventral limbus cœrulean or brassy-black; posterior margin of pro- and meta-stethium concolorous; femora flavescent beyond the middle.

Reported from India.

86. CHRYSOCORIS, Fabricius.

Cimex patricius, Fabr., Ent. Syst. Suppt. p. 527 (1798); Stoll, Punaises, p. 125, t. 32, f. 222A (1788).

Tetyra patricia, Fabr., Syst. Rhyng. p. 131 (1803); Schiödte in Kröyer's Nat. Tidsskr. iv, p. 286 (1842).

Scutellera patricius, Guérin, Voy. La Coquille, Ins. p. 159 (1830).

Callidea bengalensis, Westwood, Hope, Cat. Hem. i, p. 15 (1837); Germar, Zeitschr. i (i), p. 118, (1839); Dallas, List Hem. i, p. 28 (1851): Walker, Cat. Het. i, p. 27 (1867).

Callidea basilica, Germar, Zeitschr. i (i), p. 117 (1839): Walker, l. c. i, p. 28 (1867).

Callidea patricia, Germar, *l. c.* p. 121 (1839); Walker, l. c. i, p. 2 8 (1867).

C. (Chrysocoris) patricius, Stål, Hem. Fabr. i, p. 11 (1868); En. Hem. iii, p. 20 (1873).

Oblong, one-third the size of *S. nobilis:* head, thorax and scutellum cœrulean blue: head shining, with a dorsal line and a spot on each side at the base, black: thorax with a dorsal line and four spots on each side, black: scutellum large, with nine spots arranged 3, 3, 2, 1, black: body flavescent, marginal bands cœrulean, and the margin of the abdomen, red: feet black, femora rufous *(Fabr.)*. Dark greenish-blue; pronotum with seven spots, scutellum with eight large black spots; femora rufous, apex and tibiæ green; trochanters whitish; abdomen palely luteous, margin purplish-rufous, with oblong, transverse, greenish-black spots *(C. bengalensis*, West.), a somewhat ovate median oblong spot, with a longitudinal row of three rounded spots on both sides and a rounded spot before apex black. Pectus shining, sparingly punctured, brassy-green or cyaneous, six spots at the insertion of the feet and anterior and posterior margins of meso- and meta-sternum, yellow; posterior margin of pro-sternum, yellow, lateral margin and posterior angles, red: lobes of anterior margin very short, truncate, externally angulate. Hemelytra black-cœrulean, internally fuscescent their exterior margin yellow towards the base; membrane and wings fuscous-black. Feet pubescent; coxæ, trochanters and femora, red, the femora cyaneous at apex, tibiæ with a small groove before apex, cyaneous; tarsi-black: venter moderately convex with the sides punctured, shining, yellow, margin above the black stigmata red or luteous, a large quadrate spot occupying the middle of the three anterior segments and another rounded on penultimate segment, black or fuscous; 2-5 segments with a brassy-green spot on each side: anal segment horizontal, æneseent, thrice broader than length, deeply transversely impressed, the apex broadly emarginate.

♀. The ♀ has the antennæ more slender, shorter than head and pronotum, two basal joints longer than the eyes, 3-5 joints with small obsolete grooves: sides of pronotum more narrowly margined before the eyes, margin not dilated in the middle: anal segment of venter deep red (*Schiödte*). Long, 7½-8 mill., humeral breadth, 4¾ mill.

The discoidal spot in the scutellum is broader than in *C. elatus*, Stål, gradually amplified forwards before the middle: genitalia in ♂ more reflexed behind the middle than usual: subapical rounded spot in the scutellum black.

Reported from Bengal, Tranquebar: the Indian museum has specimens from Calcutta and Ceylon.

♂. Antennæ a little longer than the head and pronotum together, stoutish; two basal joints much shorter than the head, scarcely as long as the eyes, either black, or fuscous, or rufescent; second joint very short, one-fourth the length of the basal; remaining joints black, pubescent, almost of the same length, depressed, with a small groove on the upperside; third thrice as long as the basal, fourth and fifth with a deep groove on the lower side. Head deflexed much shorter than broad, obtusely three-angled, and a little convex, smooth, shining, cœrulean greenish or cyanean; clypeus obscurely cyaneous, at the extreme apex ruddy; eyes of moderate size, prominent; clypeus linear, obtusely prominulous at apex; margins of the rostral groove, narrowly elevated: rostrum reaching the base of the abdomen subcylindrical, piceous, rufescent at base, second joint a little longer than the rest. Pronotum broader than long, convex at the base, as high as the scutellum, more sparingly punctured, denser towards the somewhat elevated humeri, anteriorly convexly sloped, smooth, within the apex depressed and rather densely punctured; entirely brassy-green or shining cyaneous, sometimes purpurascent at the sides, with three longitudinal rows of black spots of which the median row is composed of two large quadrate spots and the lateral rows of three smaller, rounded spots: the humeral protuberances are also black and the lateral margins before the obtuse-angled, rounded humeri somewhat straight. Scutellum ovate almost twice as long as the pronotum, almost one-half longer than basal breadth, shorter than abdomen, moderately convex, basal semilunar elevation rather high, flatly inclined at the sides, posteriorly convexly sloped, somewhat depressed and truncate at the extreme apex; densely punctured, basal callus smooth, shining cœrulean or cyaneous, sides and apex more or less purple.

87. CHRYSOCORIS PURPUREUS, Westwood.

Cimex stockerus, Fabricius, (nec Linn.) Syst. Ent. p. 696 (1775); Spec. Ins. ii, p. 338 (1781); Mant. Ins. ii, p. 280 (1787); Ent. Syst. iv, p. 79 (1794); Wolff, Ic. Cim. ii, p. 47, t. 5, f. 44 (1801): Stoll, Punaises, p. 17, f. 15, 16A. (1788).

Tetyra stockerus, Fabr., Syst. Rhyng. p. 131 (1803).

Scutellera stockerus, Latr., Gen. Ins. iii, p. 131 (1807).

Callidea stockerus, Burm., Handb. ii (i) p. 394 (1835): Westwood in Donovan's Ins. China, p. 48, t, 21, f. 1 (1842).

Callidea purpurea, Westwood, Hope, Cat. Hem. i, p. 15 (1837): Germar, Zeitschr. i (i) p. 115 (1839); Dallas, List Hem. i, p. 26 (1851); Vollenhoven, Faune Ent. l'Arch. Indo-Néer. i, p. 31 (1863); Walker, Cat. Het. i, p. 26 (1867).

C. (*Chrysocoris*) *purpureus*, Stål, Hem. Fabr. i, p. 10, 11 (1868); En. Hem. iii, p. 21 (1873): Distant, A. M. N. H. (5 s.) iii, p. 44 (1879).

Cærulean-purple: pronotum with 5 and scutellum with 6-7 spots, antennæ and tarsi, black; body beneath, luteous, margined purple and with purple stigmata; anus golden; femora luteous with apex and tibiæ purple; tarsi black (*C. purpureus*, Westw.) Stål notes that in his examples the pronotum has only two spots anteriorly and the discoidal spot on the scutellum is smallish and oblong. Vollenhoven gives the colour above as deep blue, head slightly tumid, and transversely wrinkled, eyes blackish, ocelli yellowish-brown; antennæ black, first joint blue, orange at the base, second joint one-fourth the length of the third in the ♀: basal half of the rostrum yellow, rest brown, reaching second ventral segment: pronotum rather elevated, without a transverse groove, strongly punctured, with five (2 and 3) black spots: scutellum strongly punctured (except at the basal elevation which is almost smooth,) with six black spots arranged in two rows and a median triangular spot which is sometimes obsolete and is replaced by a green reflection: body beneath yellow or orange with the exception of the head and the margins of the pectus which are violet, of the margin of the abdomen which is purple and of a basal spot on the venter and small stigmatal spots which are black: feet orange as far as two-thirds of the femora, remainder violet, tarsi black. Body long. 15-17 mill.

Reported from Bengal, Bombay, Assam. Specimens from Assam vary in colour from purplish to sanguineous above. The Indian museum has specimens from Utakamand, S. India and Bihár.

88. CHRYSOCORIS VIRIDIS, Atkinson.

Proc. A. S. B. p. 12, (1887).

Allied to *C. purpureus*, Westw. Above light brassy-green, densely punctured: antennæ black, basal joint brown, rostrum almost reaching apex of second ventral segment: head and pronotum irrorated golden, the latter with a smoother transverse band close to, and parallel with anterior margin, and bearing slight traces of three blackish spots also traces of three median distant spots, lateral margins slightly reflexed, posterior angles slightly prominulous: scutellum with a steel-blue, smooth, semicircular, basal elevation; on each side, three smallish black spots, the basal resting on the basal elevation, no discoidal or apical mark; beneath very sordid flavescent turning into ferruginous, sides of pectus brassy-green, stigmata black, irrorated green, base of anal segment slightly black, no black spot on basal segment: feet somewhat ferruginous, apex of femora, and tibiæ externally, brassy-green. Differs from *C. purpureus* in colour and markings above, in the less-obtuse apex of scutellum, and absence of purple border and black basal patch on the abdomen. Long, 15-16 mill.

From the Panjab,

89. CHRYSOCORIS STOLLII, Wolff.

Cimex stollii, Wolff, Ic. Cim. ii, p. 48, t. 5, f. 45 (1801).

Scutellum stockerus, Guérin, Voy. La Coquille, Ins. ii, p. 159 and 161 (1830).

Callidea stollii, Germar, Zeitschr. i (i) p. 114 (1839); Dallas, List Hem. i, p. 26 (1851); Walker, Cat. Het. i, p. 27 (1867), excl. syn.

C. (*Chrysocoris*) *stollii*, Stål, Hem. Fabr. i, p. 11 (1868): En. Hem. iii, p. 21 (1873).

Antennæ 5-jointed, black, first joint ferruginous: head, thorax and scutellum cœrulean: head very shining with a longitudinal streak and a spot on both sides at the fuscous eyes, black; two small impressed lines on the apex: rostrum 4-jointed, black, flavescent at the base: thorax with six black spots, the anterior three small, the posterior three large, oblong; posterior angles rather prominulous, black: scutellum shining greenish, margin and apex purple; with eight black spots, three on each side, one in the middle oblong and large, and one at the apex (sometimes obsolete) transverse: hemelytra black, shining cœrulean; exterior margin, rufous; interior margin broadly whitish: membrane fuscescent, striated externally black: wings hyaline with a large black spot on the apex: abdomen beneath flavescent, throughout very finely impressly punctured, margin purple, on both sides with five black points on some of which is a small line: pectus flavescent with three violaceous spots on each side: anus with a black spot: feet unarmed; femora flavescent, at the apex violaceous; tibiæ violaceous (*Wolff*). Long, 13½—14 mill.

Reported from China, Cambodia, Siam, Tenasserim, Burma, Assam, N. India.

Differs from *C. purpureus*, Westw. in its smaller, narrower body, thorax more elevated posteriorly, scutellum deeply impressed at the base and the number of the spots.

The discoidal spot on the scutellum is broadish and obovate.

90. CHRYSOCORIS PORPHYRICOLUS, Walker.

Callidea porphyricala, Walker, Cat. Het. i, p. 29 (1867).
Chrysocoris porphyricolus, Distant, J. A. S. Ben. xlviii (2), p. 37 (1879).

Gilded green, nearly fusiform, minutely punctured: head with a blackish stripe which has on each side of it a blackish spot and is bordered by two deep parallel furrows: pronotum with three longitudinally elongated purple spots in front of which there are three transversely elongated spots; a small cupreous spot on each angle near the hird border; scutellum with three large purple spots on each side; a slight transverse furrow which is curved to the anterior border on each side, tip purple: abdomen beneath red with black dots along each side of it and with a black subapical patch: legs red; femora towards their tips and tibiæ purple; tarsi black. (*Walker.*) Body long, 15 mill.

Reported from India, the Indian museum has specimens from Tenasserim and Sikkim: differs from preceding in the purplish tint more or less throughout above and the larger size of the spots.

91. CHRYSOCORIS ORNATUS, Dallas.

Callidea ornata, Dallas, List Hem. i, p. 27 (1851).
C. (*Chrysocoris*) *ornatus*, Stål En. Hem. iii, p. 21 (1873).

Above brilliant golden-green, becoming purplish after death (?), thickly and rather strongly punctured: head impunctate with a black spot on the vertex: pronotum with three small black spots close to the anterior margin, three large ones touching the posterior margin and one in each lateral angle: scutellum with the basal elevation smooth nearly impunctate, with a large triangular black patch on the disc, a large oblong black spot on each side of this, at the middle of the scutellum, and two smaller ones towards the apex: abdomen bright orange-red with the margins crimson; the stigmata and a large spot at the base and the apex, black: pectus violet, tinged with golden green: legs, rostrum and antennæ black, the legs tinged with violet (*Dallas*). Body long, 13½-14 mill.

Reported from China, Assam. Not strongly distinct from *C. stollii*, pectus without flavescent spots and lines, entire feet cœrulean-black.

92. CHRYSOCORIS PULCHELLUS, Dallas.

Callidea pulchella, Dallas, List Hem. i p. 25 (1851): Walker, Cat. Het. i, p. 26 (1867).

Chrysocoris pulchellus, Stål, En. Hem. iii, p. 22 (1873).

Closely allied to *C. marginellus*, Westw., but differs in its smaller size, in having the antennæ much broader and thicker and the second joint smaller than in that species; the head, in addition to the median longitudinal line has a small black spot on each side in front of the ocelli; the black spots also occupy more of the surface than in *C. marginellus* and are arranged precisely in the same manner; namely, nine on the pronotum of which three small ones on the anterior margin, one in each lateral angle and four large oblong ones on the disc towards the posterior margin; eight on the scutellum, placed, two, close to the base, forming an interrupted transverse band, a somewhat triangular one on middle of disc, one on each side of this, two behind the middle and one close to the apex: abdomen yellow with the margin crimson; stigmata, black, with a row of golden green spots within them and within these, another row of black ones; a black patch at the base and apex of abdomen: pectus violet and green: coxæ yellow: femora red with their tips, tibiæ, tarsi, rostrum and antennæ black. (*Dallas.*) Body long, 12½ mill.

Reported from India, Silhat.

93. CHRYSOCORIS ANDAMANENSIS, Atkinson.

Proc. A. S. B. p. 12, (1887):

Above deep blue turning into purplish or into green, or green, shining, deeply and densely punctured: eyes and ocelli brown: antennæ black, basal joint flavescent (except the apex): rostrum flavescent, reaching posterior coxæ: thorax densely punctured, transversely sulcate before the middle, with a broad smooth band close to anterior border, marked by three black, oblong, transverro spots, also between the band and the base, three large, longitudinal, black spots of which the median is triangular with its apex pointing forwards; margins slightly reflexed, posterior angles slightly prominulous and blackish: scutellum with a semicircular basal elevation, smooth, immaculate; three rounded spots on each side, of which the last is the largest, and a linear longitudinal median basal streak, black; broad apical limbus bright orange: body beneath flavescent, sides of pectus, stigmata, and transverse streaks therefrom on anterior margin of each segment on both sides, apex of femora and tibiæ externally, steel-blue; anal segment violet-black. Easily distinguished by its size and the broad, orange, apical limbus of the scutellum. Long, 17; breadth of pronotum, 9 mill.

The Indian Museum possesses a long series from the Andaman Islands.

94. CHRYSOCORIS MARGINELLUS, Westwood.

Callidea marginella, Westwood, Hope, Cat. Hem. i, p. 15 (1837): Germar, Zeitschr. i (i) p. 117 (1839); Dallas, List Hem. i, p. 25 (1851); Walker, Cat. Het. i, p. 26 (1867).

Callidea cælestis, Stål, Ofvers. K. V.-A. Förh. xii, p. 181 (1855); l. c. xiii, p. 52 (1856); Walker, l. c. iii, p. 510 (1868).

C. (Chrysocoris) marginellus, Stål, Hem. Fabr. i, p. 12 (1868); En. Hem. iii, p. 21 (1873).

Size of *C. purpureus*, Westw.: cœrulean-green, thorax with twelve spots, two intermediate, oblong; scutellum with nine, and an oblong anterior median stripe, black: thorax beneath golden-green; abdomen palely luteous with golden-greenish submarginal spots, margin broadly purple, stigmata black; femora rufous-fulvous, apex and tibiæ green (*Westw.*). Body long, 13-14 mill.

♂. Obscurely virescent-chalybeous; thorax with 11 black spots; scutellum densely and deeply punctured, with a basal transverse elevation, with 8 black spots of which the median longitudinal: pectus more obscure, yellow at the coxæ; abdomen yellow, each segment having on both sides a chalybeous-violaceous spot, last segment violaceous-black: femora cinnabar, apex and the tibiæ chalybeous: antennæ and tarsi, black. Head green chalybeous, subimpunctate, shining, tylus more obscure: antennæ black, second joint very minute: thorax sinuate anteriorly, sides oblique, broadly obliquely truncate on both sides posteriorly; scarcely so anteriorly, posteriorly (especially on the sides) more punctured, shining, chalybeous; adorned with eleven spots of which 3 anteriorly, 2 basal close together subelongate and 3 on each side placed triangularly, black: scutellum flatly-produced at the apex, densely and roughly punctured especially on the sides, transversely elevated at the base and there impunctate, green-chalybeous, adorned with seven rounded spots (arranged 2, 2, 2, 1) and an elongate median spot sometimes dilated at the base, black: pectus obscurely chalybeous-violaceous, yellow at the coxæ: abdomen roughly punctured on both sides, yellow, adorned with a black basal spot and obscurely chalybeous, transverse, lateral spots, last segment, violaceous-black: femora cinnabar, with apex and the tibiæ chalybeous: tarsi black. Colour sometimes somewhat golden green, margin of abdomen, weakly violacescent (*Stål*). Long, 19; broad, 9 mill.

Reported from Madras, Bengal, Bombay, Celebes, Borneo. The Indian Museum has specimens from Chandbali (S. coast of Bengal).

95. CHRYSOCORIS EQUES, Fabricius.

Callidea eques, Dallas, List Hem. i, p. 28 (1851); Walker, Cat. Het. i., p. 32 (1867).

Chrysocoris eques, Stål, Hem. Fabr. i, p. 11, 12 (1868).

C. (*Chrysocoris*) *eques*, Stål, En. Hem. iii, p. 21 (1873).

Var. *a.* *Cimex eques*, Fabr., Ent. Syst. iv, p. 79 (1794). Tranquebar.

Tetyra eques, Fabr., Syst. Rhyng. p. 131 (1803): Schiödte in Kröyer's Tidsskr. iv. p. 284 (1842).

Scutellera eques, Guérin, Voy. La Coquille, Zool. ii, p. 158 (1830). Philippines.

Callidea eques, Burm., Handb. ii (i) p. 394 (1835); Germar, Zeitschr. i (i) p. 112 (1839): Voll., Faune Ent. l'Arch. Indo-Néer. p. 27 (1863).

Galostha eques, Am. & Serv., Hist. Nat. Ins. Hèm. p. 33 (1843).

Var. *b.* *Callidea schwaneri*, Vollenhoven, Faune l'Arch. Indo-Néer. p. 26, t. 2, f. 7 (1863); Walker, l. c. iii, p. 511 (1868). Borneo.

Var. *c.* Var. *nicobarensis*, Atkinson, Proc. A. S. B. p. 13, 1887). Nicobars.

Callidea eques, Mayr, Reise Novara, p. 24 (1866). Nicobars.

Var. *d.* *Callidea formosa*, Westwood. Hope, Cat. Hom. i, p. 15 (1837); Germar, Zeitschr. i (i) p. 113 (1839). China.

Callidea dorsalis, White in Gray's Zool. Misc. p. 80 (1842).

Var. *a.* Body ovate, above green: a band on the head between the antennæ emitting a branch up to the base and two small spots, deep black: dorsal line on thorax and four spots on each side (3, 1) deep black: scutellum large with eight deep black spots (2, 2, 2, 1) and the dorsal spot anteriorly bifid: abdomen black, margin green with black points: feet cœrulean (*C. eques*, Fabr.). Long, 11—13 mill.

Var. *b.* Head flat, smooth, green, with the ocular margin blue: the eyes and ocelli brown: antennæ black, very pubescent, the second joint only one-fifth the length of the following: pronotum a little punctured, except perhaps on the anterior angles; lateral margins much dilated, green or blue, disc golden: scutellum very tumid without a basal elevation, much punctured, principally near the anterior angles, a little flattened at the apex; colour green or golden red with a more or less large black spot at the extremity: deep violet beneath, middle of the venter black also the tarsi, or venter green with a large discal streak and small marginal spots, black. This variety has the following subvarieties:—

1. Black spots on the lateral angles of the pronotum.
2. In addition, a black spot on the anterior margin of the pronotum.

3. a T-shaped spot or two small lines on the disc of the scutellum.

4. Seven rather indistinct spots on the pronotum, scutellum with a small median line, two lateral and one anal spot.

5. Five rather distinct spots on the pronotum and five larger on the scutellum (*C. schwaneri*, Voll.).

Long, 11-12 mill.: all from Borneo.

Var. c. *nicobaricus*, mihi, is represented in the Indian Museum by a long series from the Nicobar islands.

Above shining green; eyes brown; antennæ black: pronotum with the lateral margins much dilated, semicircularly rounded, edged black; anteriorly with a transverse row of three black spots of which the median is largest, triangular, having its apex pointing hindward; three black spots arranged in form of a triangle at the posterior angles, sometimes but two, and then with the basal margin black, on which rests a median triangular spot with its apex turning forwards and meeting the triangular median spot of the anterior row: scutellum without a basal elevation, no discal spot, three black spots on each side and one at the apex: body beneath entirely brassy-green, tinted violet or steel blue, especially on the pectus, a small median transverse patch on the anterior margin of each segment, also the stigmata and base of anal segment violet black: feet of a steel blue, tibiæ internally sordid ferruginous. Long, 11-12 mill.

Mayr describes what is probably the ♂ of this variety, also from the Nicobars, as having the pronotum anteriorly with three black marks of which the median is largest, in the middle with two rounded black marks and near the posterior margin three like them, of which the median is connected by means of a black line with the median mark on the anterior border: scutellum shining green, bluish on both sides with three pair of blackish spots, of which the anterior and median pair are rounded, the posterior transverse; the median Y-shaped mark is wanting and there is hardly any trace of the usual apical black spot: the basal segments of the abdomen are for the most part violet and somewhat green, the median are green with blackish-violet oblong streaks, stigmata violet and base of anal segment black.

Var. *d*. Brassy-green, pronotum with the sides reflexed, broader than the scutellum, spotted black and with two large, rounded dorsal spots, sanguineous; scutellum sanguineous; body beneath and feet brassy, the former spotted black, the stigmata deep blue (*C. formosa*, Westw.). Body long, 11-12 mill.

Reported from China.

Reported from Tranquebar, Malacca, Singapore, Banca, Sumatra, Java, Borneo. The Indian Museum has a long series of variety *c*. from the Nicobar Islands.

96. CHRYSOCORIS DILATICOLLIS, Guérin.

Scutellera dilaticollis, Guérin, Voy. La Coquille, Zool. ii, (2) p. 160, 164 (1830).

Chrysocoris stollii, Hahn (nec Wolff), Wanz. Ins. ii, p. 39, t. 44, f. 136 (1834).

Callidea abdominalis, Westwood, Hope, Cat. Hem. i, p. 15 (1837); Germar, Zeitschr. i (i) p. 112 (1839).

Galostha stockerus, Am. & Serv. Hist. Nat. Ins. Hèm. p. 34 (1843).

Callidea dilaticollis, Dallas, List Hem. i, p. 28 (1851); Walker, Cat. Het. i, p. 28 (1867): Vollenhoven, Faune Ent. l'Arch. Indo-Néer. p. 28 (1863).

Callidea stockerus, Stål, Ofvers. K. V.-A. Förh. p. 389 (1855).

Chrysocoris stockerus, Stål, Hem. Fabr. i, p. 12 (1868).

Var. *Callidea sumatrana*, Vollenhoven, l. c. p. 28, t. 2, f. 9 (1863).

C. (*Chrysocoris*) *dilaticollis*, Stål, En. Hem. iii, p. 21 (1873).

Above shining blue, more or less greenish: head broad, triangular; eyes prominulous; median longitudinal line, black: antennæ black, in ♂ at least as long as the body, in ♀ shorter, two last joints comparatively stout: thorax anteriorly as broad as the head, abruptly produced posteriorly in a small, fine, rounded dilatation on each side; no depression in front, broader than the scutellum and almost twice broader than long, surface smooth or very weakly punctured; with two rows of three round, rather large black spots, and the lateral dilatation, also, black in the middle: scutellum with seven round, black spots and a large triangular spot towards the base, very broad in front, a little emarginate on the sides and having in some specimens a small green line in the middle; the posterior spot is placed in the middle and near the tip: thorax beneath of a beautiful shining green, with small yellow lines, on the sutures: rostrum green, with the base orange: abdomen bright orange yellow, with a quadrate patch at the base and the anus black-blue; sides green with two rows of four black dots on each side: femora bright orange yellow with their tips, the tibiæ and tarsi blue-green *(Guérin)*. Long, 10—12; broad at the base of the scutellum, 5½—6 mill.

Reported from Java, Sumatra, Celebes, Timor, Malacca, Burma, India, China. The Indian Museum possesses specimens from Arakan in which the abdomen beneath is almost entirely dark brassy-green, the disc of the last three segments alone being orange yellow and in this respect approaches Var. *sumatrana*, Voll.

Genus LAMPROCORIS, Stål.

Hem. Afric. i, p. 34 (1864); Mayr, Reise Novara, Hem. p. 18 (1866): Stål, En. Hem. iii, p. 9, 22 (1873). Includes *Sophela*, Walker, Cat. Het. i, p. 17 (1867).

Stål distributes the species belonging to this genus amongst the subgenera *Lamprocoris* and *Sophela*, both of which are represented in India. Third joint of the antennæ longer than the second; tibiæ cylindrical neither flat nor furrowed above: prostethium impressed behind the eyes within the anterior margin which is amplified between the eyes and the sternum: anterior margin of the basal angles of the scutellum subreflexed; ventral segments unarmed in the apical angles; near the sides, anteriorly and posteriorly, somewhat convex or tumescent.

97. LAMPROCORIS LATERALIS, Guérin.

Scutellera lateralis, Guérin, Voy. La Coquille, Zool. ii (2) p. 159, 160 (1830).

Callidea lateralis, Dallas, List Hem. i, p. 28 (1851); Walker, Cat. Het. i, p. 28 (1867): Vollenhoven, Faune Ent. l'Arch. Indo-Néerl. p. 32, t. 2, f. 11 (1863).

L. (*Lamprocoris*) *lateralis*, Stål, Berlin Ent. Zeitschr. x, p. 155 (1866); En. Hem iii, p. 22 (1873).

Head rounded at the tip, triangular, punctured, with two longitudinal grooves in the middle; green, shining, the sides and the space between the grooves of a rich Prussian blue: antennæ black: pronotum and scutellum bluish-green, the former very tumid and very broad behind, punctured, lateral posterior angles rather prominulous; above and anteriorly, with two oblong black spots, placed transversely and trending a little obliquely, towards the tip of a median and longitudinal line of which the extremity reaches their level and which ends at the posterior margin; on each side of this line are three long oblique spots which do not reach the posterior margin: scutellum punctured, with three transverse rows of black marks, of which five are on the anterior margin in the form of a crescent, four towards the middle, of which the two median are much the largest, three behind these, almost united by a weak brown mark, two more behind these last and often a very small transverse spot at the posterior extremity: body beneath is of the same colour as above: abdomen with a broad red band, commencing close to the base and ending near the anus, it occupies half the first segment, the 2-4 and half the fifth segment, and has four black-brown stigmatic dots on the margin: feet concolorous: hemelytra brown; wings transparent, tip alone infuscate (*Guérin*). Long, 9—10; broad, 6—6½ mill.

Reported from Java, Sumatra, Assam. The Indian Museum possesses a specimen from Sikkim.

98. LAMPROCORIS ROYLII, Westwood.

Callidea Roylii, Westwood, Hope, Cat. Hem. i, p. 16 (1837): Germar, Zeitschr. i (i) p. 119 (1839): Dallas, List. Hem. i, p. 28 (1851); Walker Cat. Het. i, p. 28 (1867).

Var. *Scutellera pulchella*, Westwood, Royle, Ill. Bot. Him. p. liv, t. 10, f. 6 (1839).

Lamprocoris roylii, Stål, En. Hem. iii, p. 22 (1873): Distant, A. M. N. H. (5 s.) iii, p. 44 (1879).

Rufous cupreous or golden, varied with black: pronotum with the dorsal line, three spots on each side and the humeral angle, black: scutellum with three basal and five apical spots, also a broad lunated band in the middle, black, margined green: body beneath greenish; abdomen with black band and on the margins rufous spots (*C. Roylii*, Westw.). Body long, 9½ mill.

Brassy or cœrulean-black, shining: disc of pronotum anteriorly and posterior margin tinted cupreous or brassy: scutellum, intensely green and gold, a transverse basal band and another median oblique (interrupted in the middle), and three rounded spots (posteriorly and arranged in form of a triangle), cœrulean black: scutellum covering the abdomen: two basal joints of antennæ short, equal, third almost twice as long as the second, last longest of all. Long, 10½; broad, 6¼ mill. (*S. pulchella*, Westw.)

Reported from the Himálaya, Bengal, Nepál, Assam. The Indian Museum has specimens from Sikkim and Mussoorie.

99. LAMPROCORIS OBTUSUS, Westwood.

Callidea obtusa, Westw., Hope, Cat. Hem. i, p. 16 (1837); Germar, Zeitschr. i (i), p. 119 (1839): Voll., Faune Ent. l'Arch. Ind. Néerl. i, p. 32 (1863): Walker, Cat. Het. iii, p. 510 (1868).

L. (Lamprocoris) obtusus, Stål, En. Hem. iii, p. 22 (1873).

Golden-green: two anterior spots on the thorax, a dorsal line and four other oblique, black: eleven black spots on the scutellum: body beneath and the feet, black with a golden tinge; margin of abdomen, fulvous, stigmata black (*Westw.*). Long, 9½ mill.

Reported from Java.

100. LAMPROCORIS SPINIGER, Dallas.

Callidea spinigera, Dallas, Trans. Ent. Soc. v, p. 186, t. 19, f. 1 (1849).

Sophela spinigera, Walker, Cat. Het. i, p. 18 (1867).

Lamprocoris (Sophela) spinigera, Stål, En. Hem. iii, p. 22 (1873): Distant, A. M. N. H. (5 s.) iii, p. 44 (1879).

Broadly ovate, rather convex; above brownish testaceous, with violet or brassy reflections, very thickly and finely punctured: head violet, shining, faintly punctured and transversely wrinkled, the tylus darker in colour; eyes brown, ocelli red: pronotum faintly punctured with the lateral angles produced into a small acute spine on each side, the anterior and lateral margins and in the ♂ the whole anterior portion, cupreous or violet, shining: on each side, towards the anterior margin, is a small transverse fovea, surrounded by a brassy green ring: scutellum very finely punctured and faintly wrinkled transversely, especially at the base which is brassy, cupreous or violet : hemelytra with the margins pale testaceous : margins of the abdomen projecting slightly beyond the scutellum, bright red, crenated, each segment bearing two small projections or tubercles; abdomen beneath, deep blue violet, very smooth and finely punctured, with a strong brassy-green reflection; a violet line on the margin of each segment, running between the red tubercles ; anal apparatus red, violet at base in ♂ : pectus shining violet, punctured; the antero-lateral margins and the prominent lateral angles, reddish : legs shining violet, finely piloso; tarsi black: antennæ and rostrum black, the former covered with short hairs. *(Dallas.)* ♂, long with membrane 15 ; ♀, 16 mill.

Reported from N. India, Assam, Sikkim (Ind. Mus.): varies somewhat in the colouring above and beneath : above often purplish nacreous, beneath the disc of abdomen shining red.

Div. TETYRARIA, Stål.

En. Hem. iii, p. 3, 24 (1873).

Body beneath distinctly convex, generally above and below equally convex or below more convex: thorax and scutellum at the base conjointly gradually longitudinally convex, very rarely slightly convexly inclined, basal part of thorax somewhat produced backwards between the basal angles of the scutellum or the thorax posteriorly gradually rounded between the lateral angles, basal angles very obtuse or rounded: venter in both sexes with two stridulatory spots, longitudinally very densely and very finely strigose, oblong or elongate, extended through at least the fourth and fifth segments, sometimes difficult to distinguish, intermediate incisures straight on the disc or biundated, abruptly and obtusely subangulately curved at the sides of the disc: orifices very distinct (*Stål).*

Genus HOTEA, Am. & Serv.

Hist. Nat. Ins. Hém. p. 41 (1843) : Dallas, List Hem. i, p. 5, 39 (1851): Mayr, Reise Novara Hem. p. 15 (1866): Walker, Cat. Het., i, p. 55 (1867): Stål, Hem. Afric. i, p. 35, 53 (1864); En. Hem. iii, p. 24 (1873).

Body nude, above and beneath convex: head altogether convex, with a continued median lobe, bucculæ rather elevated before the middle: second and third joints of the antennæ subequal in length, or the second a little longer than the third : thorax sexangular, anterior lateral margins, distinctly sinuated, lateral angles produced, more or less acuminate, posterior angles rounded, posterior margin straight: scutellum as broad as the abdomen, rounded at the apex, not produced : prostethium dilated anteriorly, covering the base of the antennæ: sterna slightly sulcated: disc of venter with two sericeous-shining spots, last segment sinuated at the apex: feet somewhat robust, tibiæ above flat *(Stål)*.

101. HOTEA CURCULIONIDES, Herr. Schäff.

Pachycoris curculionides, Herr. Schäff., Wanz. Ins. iii, p. 106, t. 107, f. 331 (1835); Germar, Zeitschr. i (i) p. 106 (1839).

Pachycoris punctulatus, Germar, l. c. p. 105 (1839).

Hotea curculionides, Dallas, List Hom. i, p. 39 (1851); Walker, Cat. Hom. i p. 56 (1867); Vollenhoven, Faune Ent. l'Arch. Indo-Néer. p. 37 (1863).

Hotea (Tylonca) curculionides, Stål, En. Hom. iii, p. 25 (1873); Distant, J. A. S. B. xlviii (2) p. 37 (1879); A. M. N. H. (5 s.) iii, p. 44 (1879).

Ochraceous, deeply and thickly punctured brown or black, except on the vertex and anterior margins of the pronotum where the colour is more yellow: head beneath black, except the borders of the rostral groove: eyes and ocelli greyish yellow, the latter very small: two first joints of the antennæ yellow, the two next brownish and the last, brown: the feet are even more punctured than the body: the tibiæ reddish. This species varies much in the depth of its brown colour and the punctures more or less strong and black; Germar's *H. punctulata* is of a very deep brown; some specimens have three longitudinal lines on the head and thorax less punctured and lighter, and a zigzag transverse band on the scutellum, from the most advanced portion of which proceed three other light lines which reach the margins *(Voll.)*. Long, 8—9 mill.

Schäffer's figure shows the upper surface deep brown without spots. The Calcutta form has four longitudinal patches of a deeper colour proceeding from the anterior margin of the pronotum, the two median are continued obliquely inward almost to the posterior margin where they meet. The scutellum has on each side an oblique small oblong spot near the base on each side, and a large subquadrate patch on each side beyond the middle, and two at the apex, all of a darker colour. Specimens from Tavoy and Assam have the same spots more or less distinct.

Reported from Amboina, Java, Sunda, Celebes, Timor, Ternate, Sumatra, Assam. The Indian Museum possesses specimens from Tavoy, Calcutta and Sikkim.

102. HOTEA NIGRORUFA, Walker.

Hotea nigrorufa, Walker, Cat. Het. i, p. 57 (1867).

Red, short-elliptical, thickly black-punctured, and with numerous small irregular black marks: head with five irregular red lines, and with two longitudinal furrows: antennæ black; first joint red; fourth red at the tip: thorax with a red longitudinal line; sides luteous; angles acute: scutellum with an apical patch, which is not varied with black: abdomen luteous along each side: legs red, black speckled; tarsi black: hemelytra brown; corium red, with black punctures: wings cinereous. Var. *a.* body red, with the exception of the punctures. Var. *b.* like var. *a*: punctures red, here and there black. (*Walker*). Body long, 10½ mill.

Reported from India.

103. HOTEA(?) DIFFUSA, Walker.

Hotea (?) *diffusa*, Walker, Cat. Het. i, p. 57 (1867).

Testaceous, elliptical very minutely punctured: head slightly rostriform, with two black longitudinal lines, which in the forepart are accompanied by two slight furrows: thorax somewhat rounded along the hind border, angular on each side, contracted in front; two slight and interrupted black lines; a transverse lanceolate ferruginous-bordered mark on each side near the fore border: scutellum with a short longitudinal streak on each side, composed of minute black speckles. (*Walker*). Body long, 9½ mill.

Reported from India.

Div. ODONTOTARSARIA, Stål.

En. Hem. iii, p. 4, 26 (1873).

Head longer than broad or equally long and broad: anterior lateral margins of thorax anteriorly not, or but very slightly, rounded: propleura not, or but slightly, impressed near the lateral margins: orifices not distinguishable: second joint of antennæ straight.

Genus ALPHOCORIS, Germar.

Zeitschr. i, p. 58 (1837): Dallas, List Hem. i, p. 5 (1851): Stål, Hem. Afric. i, p. 35, 60 (1844): Mayr, Reise Novara Hem. p. 13 (1866): Walker, Cat. Het. i, p. 59 (1867).

Body stout, especially beneath convex, narrowly oval or oblong, greyish-tomentose: head stout, not margined, very convex, bucculæ rather elevated: antennæ short, somewhat longer than the head: thorax sexangular, posterior angles obtusely rounded, lateral angles not prominent, obtuse: scutellum a little produced at the apex, the produced part sinuate or somewhat sinuate at the apex: prostethium somewhat dilated at the apex: sterna deeply sulcate: ventral incisures curved (*Stål*).

104. ALPHOCORIS LIXOIDES, Germar.

Alphocoris lixoides, Germar, Zeitschr. i, p. 59, t. i, f. 3 (1839): Am. & Serv., Hist. Nat. Ins. Hém. p. 44 (1843): Dallas, List Hem. i, p. 41 (1851): Stål, Hem. Afric. i, p. 60 (1864): En. Hem. iii, p. 26 (1873): Walker, Cat. Het. i, p. 59 (1867).

♂, ♀. Oblong, narrow, yellow-testaceous, beneath with feet (except ventral limbus) blackish: above, rather densely and distinctly punctulate, with four obsolete fuscous streaks; apex of scutellum subtruncate or slightly sinuate: disc of venter sometimes yellow-testaceous and adorned with two black streaks (*Stål*). Long, 9½—10; broad, 3—3½ mill.

Reported from North India, Senegal.

Div. EURYGASTRARIA, Stål.

En. Hem. iii, p. 4, 29, (1873): *Eurygastridæ*, pt., Dallas, List Hom. i, p. 43 (1851).

Differs from *Odontotarsaria*, in having the orifices distinct: second joint of antennæ somewhat curved.

Genus EURYGASTER, Laporte.

Subg. id. Ess. Hém. p. 69 (1832): *Eurygaster*, Stål, Hem. Afric. i, p. 61 (1864); En. Hem. i, p. 18 (1870); iii, p. 29, 30 (1873). Includes, according to Stål;—*Bellocoris*, pt., Hahn, Wanz. Ins. ii, p. 42 (1834):—*Eurygaster*, Spin., Ess. p. 365 (1837); Mulsant & Rey, Pun. Scut. p. 59 1865):—*Tetyra*, Germar, Zeitschr, i, (i) p. 72 (1839): Herr. Schäff. Wanz. Ins. v, p. 48 (1839):—*Eurygaster*, subg. *Platypleurus*, Mulsant & Rey, Pun. Scut. p. 59 (1865).

Body oval or ovate, a little convex above and beneath: head flat or very slightly convex; antennæ short, slender: thorax sexangular: scutellum with the sides parallel, much narrower than the abdomen, leaving the entire costal part of the hemelytra free: abdomen with the sides flattened broader than the thorax: orifices extended in a rather long furrow, abruptly abbreviated; sides of mesosternal furrow neither carinate nor rugose; tibiæ furrowed above. In the section to which *E. maurus*, Linn. belongs, the lateral margins of the pronotum are straight or somewhat so; the scutellum is marked on both sides at the base near the basal angles with an oblong callous spot and the smooth longitudinal line is not callous (*Platypleurus*, M. & R.).

105. EURYGASTER MAURUS, Linnæus.

E. (*Platypleurus*) *maurus*, Stål, En. Hem. iii, p. 30 (1873).

Tetyra maura, Fallen, Hem. Suec. Cim., p. 12 (1828): Burm., Handb. Ent. ii, p. 390 (1835): Germar, Zeitschr. i, p. 73 (1839); Rambur, Fauna Andal. ii, p. 100 (1841).

Eurygaster maurus, Am. & Serv., Hist. Nat. Ins. Hém. p. 63 (1843); Dallas, List Hem. i, p. 48 (1851): Fieber, Eur. Hem. p. 370 (1861): Mulsant & Rey, Pun. Franco, p. 59 (1865): Walker, Cat. Het. i, p. 66 (1867): Stål, Hem. Fabr. i, p. 12 (1868): Douglas & Scott, Brit. Hem. i, p. 65 t. 2, f. 5 (1865): Saunders, Trans. Ent. Soc. p. 119 (1875): T. Sahlb., K. S. V.-A. Handl. xvi, 4, p. 14 (1878): Distant, Trans. Ent. Soc. p. 415 (1883).

Var. *a.*—*Cimex maurus*, Linn,, Fauna Suec., p. 246 (1761): Fabr., Syst. Ent., p. 99 (1775); Ent. Syst. iv, p. 87 (1794).

Tetyra maura, Fabr., Syst. Rhyng., p. 136 (1803).

Thyreocoris austriacus, Schranck, Fauna Boioc. ii, p. 68 (1801).

Odontotarsus maurus, Spin., Ess. Hém. p. 363 (1837).

Eurygaster cognatus, Westwood, Hope, Cat. Hem. i, p. 11 (1837).

Var. *b.*—*Tetyra picta*, Fabr., Syst. Rhyng. p. 136 (1803).

Odontotarsus pictus, Spin., Ess. Hém. p. 363 (1837).

Eurygaster orientalis, Westwood, Hope, Cat. Hem. i, p. 11 (1837).

This species varies much in size and colour from brownish tawny without markings to luteous with stripes and patches of brown.

Var. *a.*—Greyish or fuscous, scutellum at the base with two white spots (*Linn.*). Rufous-brunneous, punctured black: thorax with two diverging streaks, somewhat fuscous: scutellum with two minute basal, whitish spots, and an elevated median line, paler: beneath obscurely luteous, with a black spot before the anus (*E. cognatus*, Westw.). Long, 10½ mill.

Var. *b.*—Head and thorax obscure, a little irrorated with black: scutellum large, obscure; with two callous spots as in *T. maura*, two spots in the middle and a dorsal line bifurcated posteriorly, yellow: connexivum spotted fuscous on both sides (*T. picta*, Fabr.). Fuscous-rufescent, punctured black, variegated paler; a slender line from the head to the apex of the scutellum and two other oblique lines united to it (having the appearance of a triangular scutellum) and a pair of larger spots at the sides of the scutellum: beneath rufescent, punctured black, especially in the middle of the abdomen (*E. orientalis*, Westw.). Long, 9-10 mill.

Reported from Europe, Africa, India, Japan.

Div. ODONTOSCELARIA, Stål.

En. Hem. iii, p. 4, 30 (1873).

Body setose or pilose: head transverse, somewhat semiorbicular thorax anteriorly broader than the head, anterior lateral margins distinctly rounded: the scutellum very broad: propleura deeply impressed or excavated towards the lateral margins, the part lying beyond the depression a little deflexed: venter without stridulatory strigose spots: orifices not distinguishable (*Stål*).

Genus ARCTOCORIS, Germar.

Pt., Zeitschr. i (i), p. 46 (1839): Stål, En. Hem. iii, p. 31 (1873). Includes, *Irochrotus*, Am. & Serv., Hist. Nat. Ins. Hém., p. 39 (1843); Fieber, Eur. Hom. p. 86, 377 (1861); Mayr, Reise Nov. Hem. p. 18 (1866).

Body thickly clothed with long hairs: lateral margins of thorax incised or sinuated behind the middle, between the sinus a deep transverse impression.

106. ARCTOCORIS INCISUS, Stål.

Arctocoris incisus, Stål, En. Hem. iii, p. 31 (1873).

♂. Narrowly subobovate, punctulate, black, turning above into ferruginous, greyish-pilose and subtomentose: thorax before the middle slightly roundly-narrowed, transversely impressed very distinctly in the middle, lateral margins very deeply incised in the middle, anterior angles somewhat prominent forwards. The ♂ has on the ventral disc of 4th, 5th segments on both sides, a deep black opaque, subimpressed, oval spot. Allied to *A. lanatus*, Pallas, but differs in being smaller, narrower, subobovate, narrowed hindwards, thorax only narrowed at the apex, lateral margins very deeply incised, not obtusely sinuated, and with the bucculæ more elevated *(Stål)* Long 5, breadth of pronotum, 3 mill.

Reported from Bengal.

Species of uncertain position.

107. CALLIDEA FASCIALIS, White.

Callidea fascialis, White, Trans. Ent. Soc. iii, p. 86 (1842); Dallas, List Hem. i, p. 28 (1851); Walker, Cat. Het. i, p. 27 (1867); Stål, En. Hem. iii, p. 31 (1873).

Head short, in front rather blunt, with a large pinkish-violet spot, on the side of the two impressed præocular lines, the space between these, being green: first joint of the antennæ testaceous at base, green at the tip: rostrum reaching the posterior coxæ, black at the tip, yellow at the base: thorax with seven black spots; two distant anterior ones in front connected by a narrow slightly curved black line: five posterior ones, the median, largest, and square, apparently connected together at the base by an obscure band, which has a slight pinkish hue on the posterior blunt angle of the thorax: legs yellow, femora at tip, bluish green, tibiæ rufescent, ciliated: scutellum convex, posteriorly bent down, blunt at apex, with a semicircular impression at the base, deepest on the dorsum; at the base there is a narrow, transverse black band, sinuated on the posterior margin; a little before the middle there is another transverse black band, broadest in the middle beyond which are three spots, one of them subapical: abdomen beneath, yellow, sides tinged with pink, each segment being marked laterally with a black spot, the inner sides of which are tinged with green. (*White*). Body long, 11 mill.

Reported from India, Assam.

108. CALLIDEA HISTEROIDES, Walker.

Callidea histeroides, Walker, Cat. Het. i, p. 28 (1867).

Blackish purple, short-elliptical, largely punctured: head with two longitudinal furrows which diverge between the eyes, space between the furrows somewhat ridged in front: antennæ black; second joint rather more than half the length of the first: thorax with two green stripes, very thinly punctured; punctures mostly along the fore border and along a transverse antemedial furrow; a fusiform, transverse, slightly depressed, ringlet on each side in front of the furrow: scutellum with a green band bordering a transverse furrow which is curved on each side to the fore border: abdomen beneath green, with a purplish band along the fore border of each segment and with a deeply dentate red stripe along each side: legs blackish green; tarsi black. (*Walker*). Long, 8—9 mill.

Reported from Cachar (Assam).

109. CALLIDEA GIBBULA, Walker.

Callidea gibbula, Walker, Cat. Het. i, p. 29 (1867).

Purplish black, elliptical, thinly and roughly punctured: head with two longitudinal furrows, which diverge on the vertex: thorax with a very slight transverse furrow, which is curved on each side to the base: abdomen beneath, greenish at the tip, and with two deeply dentate lateral stripes, which do not extend to the base (*Walker*). Long, 8—9 mill.

Reported from the Panjab.

110. CALLIDEA SCRIPTA, Walker.

Callidea scripta, Walker, Cat. Het. i, p. 29 (1867).

Purple, short-elliptical, largely punctured: head with two longitudinal furrows, which diverge towards the face and more towards the hind border: antennæ black; second joint nearly as long as the first: thorax with two golden green stripes, which are much abbreviated in front, and thence emit two oblique branches towards the hind angles; a fusiform transverse cupreous ringlet on each side in front: scutellum with a transverse furrow which is curved on each side to the fore border; four cupreous green-bordered bands: second, third and fourth bands connected on each side; second connected in the middle with the third, forked on each side, fourth apical: pectus blue: abdomen beneath blue; a purple band on the fore border of each segment; a dentate red stripe on each side: legs green; tarsi black *(Walker)*. Long, 9—10 mill.

Reported from Cachar (Assam), N. India.

111. CALLIDEA CONTRARIA, Walker.

Callidea contraria, Walker, Cat. Het. i, p. 30 (1867).

Gilded green, short, stout, nearly elliptical, rather thinly and roughly punctured: head purple in front with two longitudinal furrows which diverge on the vertex: antennæ black; first joint purple; second more than half the length of the first: thorax with seven short purple stripes, in front of which there is a transverse purple spot on each side: scutellum with three purple spots near the base, and with three purple bands of which the second is interrupted; three hinder transverse spots, one on each side and one subapical: pectus purple: abdomen red; under side with a row of black dots along each side with a purple disc: legs bluish green; tarsi black *(Walker)*. Long, 10—11 mill.

Reported from N. India.

112. FITHA ARDENS, Walker.

Fitha ardens, Walker, Cat. Het. i, p. 45 (1867).

Gilded green, elliptical, largely punctured: head with two longitudinal furrows, which diverge between the eyes and converge slightly on the hind border; vertex purple between the furrows: antennæ 4-jointed (?), black; first joint reddish at the base: thorax and scutellum mostly brilliant reddish cupreous; the former with six purple spots; the latter with eight purple spots; three on each side; seventh elongated, on the disc near the base; eighth sub-apical: pectus with a transverse yellow streak on each side: abdomen beneath with a bright purple stripe along each side, and with a yellow patch on the disc: legs red; tibiæ and tips of femora blackish green; tarsi black: hemelytra black; space towards the base, except the costa, cinereous, nearly hyaline: wings cinereous, nearly hyaline *(Walker)*. Long, 8½ mill.

Reported from India.

113. CÆNINA VARIOLOSA, Walker.

Cœnina variolosa, Walker, Cat. Het. i, p. 82 (1867).

Aeneous: head with a pale yellow spot on each side: antennæ yellowish, piceous towards the tips: thorax mostly yellowish, with a pale yellow border; an æneous band in front, containing two quadrate whitish spots, behind which there is an æneous spot; punctures æneous: scutellum yellowish, excepting the punctures and a patch on the disc, and three whitish spots on the fore border: legs whitish; femora at the base and coxæ black: corium yellowish, with æneous punctures *(Walker.)*. Body, long, 2 mill.

Reported from Burma.

Subfam. PENTATOMINA, Stål.

Hem. Afric. i, p. 32, 76 (1864); Ofvers. K. V.-A. Förh. (3), p. 31 (1872); En. Hem. v, p. 28 (1876).

(*a*). The primary and subtended veins of the hemelytra generally close to each other and diverging at the apex, parallel or somewhat so: hamus generally absent: scutellum varying in size, generally furnished with frena: entire basal margin of thorax touching base of the scutellum: rostral furrow anteriorly not or but very slightly narrowed.

(*b*). Rostrum extended behind the first pair of coxœ, of variable length, 1-2 joints elongate, the second entirely or to the greatest part extended behind the bucculæ.

(*c*). Scutellum generally reaching or extending beyond the middle of the abdomen, rarely short, and if so, narrow at the apex and only slightly or very slightly produced behind the frena: membrane moderate or small.

(*d*). Tarsi 3-jointed: tibiæ generally furrowed above.

(*e*). Rostrum slender, more or less remote from the labrum which is inserted below the apex of the tylus; rostral furrow anteriorly sometimes coarctate: bucculæ usually higher anteriorly, parallel, not united posteriorly.

The divisons of this large sub-family are still only tentative and cannot be satisfactorily arranged by any one working only in India away from the types. I only give when possible what may be considered a probable arrangement after consulting the very considerable literature on the subject.

Div. PODOPARIA, Stål.

En. Hem. v, p. 29 (1876).

Anterior lateral margins of the thorax produced in a tooth or spine before the lateral angles which on this account appear as if sinuate or emarginate: entire antenniferous tubercles or a great part prominulous beyond the lateral margins of the head, generally acutely produced outwards at the apex: first joint of the rostrum not extended behind the bucculæ which are everywhere equally high or posteriorly higher: eyes strongly prominulous or slightly stylate: frena sometimes occupying one-third the length of the scutellum which generally reaches the end of the abdomen.

Genus SCOTINOPHARA, Stål.

Ofvers. K. V.-A. Förh. p. 502 (1867): En. Hem. v, p. 33 (1876); Horvath, Wien Ent. Zeit. ii, p. 165 (1883).

Body ovate: head somewhat convex, more or less sinuate before the eyes; juga flattened, entirely distant, not narrowed before the anteocular sinus, not converging before the somewhat elevated tylus, rounded at the apex or roundly truncated: antenniferous tubercles placed below the lateral margins of the head and entirely prominulous beyond those margins, acutely produced outwards at the apex; bucculæ continued through, low, everywhere equally high: antennæ somewhat short, basal joint entirely visible from above, second joint distinctly shorter than the third, fifth joint scarcely or only a little stouter than the fourth elongate fusiform: rostrum reaching the last pair of coxæ: thorax transverse, furnished with a gular ring prominulous on both sides in a more or less acute tooth, and armed before the humeral angles with an acute tooth: scutellum large, longer than the corium, reaching the apex of the abdomen, slightly narrowed behind the base, the basal part with frena: prostethium furrowed, the furrow with elevated margins: second genital segment in ♂ entirely hidden, the third segment only visible. *(Horvath.)*

114. SCOTINOPHARA AFFINIS, Haglund.

Scotinophara affinis, Haglund, Stettin Ent. Zeit. xxix, p. 153 (1868); Stål, En. Hem. v, p. 33 (1876).

♀. Fuscous-lurid, beneath blackish, densely and strongly punctured; rostrum, tibiæ (base excepted) and tarsi, rufescent; pronotum anteriorly with a very minute annulated tooth, sides subsinuate, lateral angles very slightly emarginate: scutellum distinctly truncate at the apex, extended to the apex of the abdomen. Closely allied to *S. lurida* Burm. from which it scarcely differs except in the anterior tooth on the pronotum being smaller, sides of thorax more distinctly sinuate, and thorax somewhat more impressed. Rostrum reaching the last pair of coxæ: membrane almost hyaline, margin fuscescent: second joint of antennæ rufescent *(Haglund)*. Long, 9; broad scarcely 5 mill.

Reported from Rangoon.

115. SCOTINOPHARA LURIDA, Burmeister.

Tetyra lurida, Burm., Nov. Act. Ac. Cæs. Leop. Car. Nat. Cur. xvi, Suppt. (i) p. 288 (1834).

Podops luridus, Germar, Zeitschr. i (i) p. 64 (1839); Dallas, List. Hem. i, p. 52 (1851); Walker, Cat. Het. i, p. 72 (1867).

Scotinophara lurida, Stål, En. Hem. v, p. 33 (1876); Scott, A. M. N. H. (4 s.) xiv, p. 289 (1874); (5 s.) Distant, iii, p. 44 (1879); Trans. Ent. Soc. p. 415 (1883).

Fuscous: head small; eyes free, almost stylate; clypeus produced forwards, with a distinct groove on each side, in which the antennæ lie: antennæ with 1-2 joints of equal length, half as long as the third, 3-5 joints of equal length, the last incrassate: pronotum narrowed forwards, on each side on the anterior angle a small acute spine, a similar one on each humeral angle, a weak, transverse furrow beyond the middle: scutellum a little shorter than the abdomen: rostrum, tibiæ, and feet reddish. *(Burm.)* Long, 10½; broad, 6¼ mill.

Reported from Canton, Japan, Assam.

116. SCOTINOPHARA BISPINOSA, Fabricius.

Cimex bispinosus, Fabr., Ent. Syst. Suppt. p. 530 (1798).

Tetyra bispinosa, pt. Fabr., Syst. Rhyng. p. 138 (1803).

Scotinophara bispinosa, Stål, Hem. Fabr. i, p. 21 (1868); En. Hem. v, p. 33 (1876).

♀. Blackish; thorax behind the middle, scutellum, hemelytra and broad ventral limbus fuscous-flavescent, punctured ferruginous-black: antennæ, rostrum, tibiæ and tarsi greyish flavescent; last joint of antennæ, fuscous: spine of anterior and lateral angles of the thorax large, black, pallescent at the apex. Readily distinguished by the great spines of the thorax, almost equally long, pallescent at the apex and the anterior lateral margins of the thorax being straight. Head with the juga and tylus equally long, anteocular spine moderate: third joint of antennæ scarcely twice longer than the second: thorax slightly transversely impressed between the spines of the lateral angles; anterior angles with an acute spine turning outwards and forwards, subequal in length to the first joint of the antennæ; lateral angles with a spine turning outwards scarcely shorter than the spines of the anterior angles; anterior margin depressed, anterior lateral margins straight, entire, unarmed, somewhat callous behind the middle: scutellum reaching apex of abdomen, about 4th basal part somewhat narrowed hindwards, thence lateral margins subparallel, posteriorly rounded, apex obtuse, subsinuate: tubercle of apical angles of ventral segments distinct, pallid *(Stål)*. Long, 8; breadth of pronotum, 4⅓ mill.

Reported from Tranquebar.

117. SCOTINOPHARA COARCTATA, Fabricius.

Cimex coarctatus, Fabr., Ent. Syst. Suppt., p. 530 (1798).

Tetyra bispinosa, pt. Fabr., Syst. Rhyng. p. 138 (1803).

? *Podops bispinosus*, Herr. Schäff., Wanz. Ins. v, p. 45, t. 158, f. 496 (1839) Dallas, List Hem. i, p. 53 (1851).

Scotinophara coarctata, Stål, Hem. Fabr., i, p. 21 (1868); En. Hem. v, p. 33 (1876).

Body oblong, entirely obscure: very slightly shining; head and anterior part of thorax, black: thorax on each side with two small teeth, one towards the apex, the other towards the base: scutellum coarctate on both sides in the middle (*Fabr.*).

♂ Differs from *S. bispinosa*, Fabr. in having the thorax anteriorly and the head more inclined, thorax scarcely transversely impressed in the middle, teeth of its anterior and lateral angles minute, equal in size; anterior lateral margins straight, slightly rounded anteriorly (*Stål*). Long, 7; broad, 4 mill.

Reported from Tranquebar, Ceylon.

118. SCOTINOPHARA TARSALIS, Vollenhoven.

Podops tarsalis, Voll., Faune Ent. l'Arch. Indo-Néer. p. 42, t. 3, f. 8 (1863); Walker, Cat. Het. iii, p. 520 (1868).

Scotinophara tarsalis, Stål, En. Hem. v, p. 33 (1876); Distant, A. M. N. H. (5 s.) iii, p. 44 (1879).

Body above rather deep brown, covered all over with an immense number of small black dots which have the effect of making it appear almost black: head and pronotum covered with a weak yellowish pubescence: tylus a little more tumid than the juga of which the further angles are weakly prolonged: the spine on the sides of the head rather robust: first joint of antennæ of an obscure brown, the rest of a light brown: eyes blackish; ocelli rather small: pronotum emarginate anteriorly and with two strong, broad spines at the anterior angles; lateral borders weakly widened in the middle, and the lateral angles end in an acute point followed by a small notch: scutellum rather flat, a little narrowed before the middle and oval at the apex, usually with two glossy yellow spots near the basal angles: body beneath, black, punctured, with a spare yellow pubescence: rostrum light brown: femora and four first tibiæ black, posterior with half of the tibiæ light brown which is the colour of all the tarsi: angles of ventral segments and margins are nodulose (*Voll.*). Long, 6 mill.

Reported from Java, Borneo, Assam. In Assam usually with legs luteous punctured with black.

119. SCOTINOPHARA OBSCURA, Dallas.

Podops obscurus, Dallas List Hom. i, p. 52 (1851); Voll., Faune Ent. l'Arch. Indo-Néer. p. 41, t. 3, f. 6 (1863); Walker, Cat. Het. i, p. 72 (1867).

Scotinophara obscura, Stål, En. Hem. v. p. 34 (1876); Distant, A. M. N. H. (5 s.) iii, p. 44 (1879).

Above brown, obscure, thickly and rather finely punctured; head rather small, black, narrowed in front; juga longer than the tylus, but not meeting in front of it, a small spine on each side in front of the eyes: thorax blackish in front, with a short spine at each anterior angle, the antero-lateral margins nearly straight, and the lateral angles emarginate: scutellum reaching the apex of the abdomen, distinctly truncated at the apex, constricted a little before the middle: body beneath pitchy black, very thickly and finely punctured and sparingly clothed with short golden hairs: femora black with an indistinct pale band near the apex: tibiæ and tarsi pale brown: rostrum and antennæ pitchy (*Dallas*). Long, 7—8 mill.

Reported from Assam, Tenasserim, Borneo, Java.

120. SCOTINOPHARA NIGRA, Dallas.

Podops niger, Dallas, List. Hom. i, p. 53 (1851); Walker, Cat. Het. i, p. 72 (1867).

Scotinophara nigra, Stål, En. Hem. v, p. 34 (1876).

Pitchy black, somewhat obscure, thickly punctured, sprinkled with yellowish hairs: head rather long, with a strong spine before each eye; tylus as long as the juga, elevated into a tubercle about the middle: thorax gibbous in front, with a faint furrow across the middle; the antero-lateral margins reflexed, rounded; a long spine directed forwards, on each side at the anterior margin, and a small one at each lateral angle; scutellum as long as the abdomen, contracted before the middle, somewhat truncated at the apex, with a small pit in each basal angle: outer margin of the hemelytra and the edge of the abdomen pitchy red: legs concolorous; tarsi ferruginous: rostrum pitchy red, with the basal joint black: antennæ pitchy (*Dallas*). Long, 7½-8 mill.

Reported from India?

121. SCOTINOPHARA SPINIFERA, Westwood.

Podops spinifera, Westwood, Hope, Cat. Hem. i, p, 16 (1837); Stål, En. Hem. v, p. 125 (1876).

Black, coarsely punctured; head anteriorly attenuated, subtruncate at the apex; a porrect spine on both sides before the eyes: pronotum scabrous anteriorly, abruptly elevated, sides acutely serrate and furnished with a lateral tooth; posterior angles of the abdominal segments, acute (*Westw.*): Long, 8½ mill.

Reported from Bengal.

122. SCOTINOPHARA LIMOSA, Walker.

Podops limosus, Walker, Cat. Het. i, p. 72 (1867).

Tawny, punctured, piceous beneath: head carinated: pronotum with an obliquely porrect spine on each side in front; hind angles forming two acute teeth: scutellum extending almost to the tip of the abdomen, much narrower than the breadth of the abdomen which is tawny along each side, beneath: femora piceous (*Walker*). Long, 6-7 mill.

Reported from N. India: the colour distinguishes it from *S. nigra*, Dallas, with which it agrees in structure.

Genus STORTHECORIS, Horvath.

Wien. Ent. Zeit. ii, p. 296 (1883).

Body briefly oval: head transverse, slightly convex, gradually dilated forwards before the anteocular sinus: juga flattened, entirely distant, not converging before the somewhat elevated tylus: antenniferous tubercles produced outward in a conical spine placed in the same plane with the lateral margins of the head; bucculæ continued through, low, everywhere equally high: antennæ shortish, basal joint altogether visible from above, stoutish, second joint much shorter than the third, fourth joint somewhat shorter than the third, fifth joint a little stouter than the fourth, elongate-fusiform: thorax transverse, anterior lateral margins acute, irregularly serrated, furnished with a process behind the anterior angle, produced in an acutish tooth before the humeral angles, disc transversely impressed in the middle, anterior lobe somewhat rugose, furnished on each side with a transverse furrow behind the anterior margin which gradually disappears towards the anterior angles and there approaches the anterior margin: scutellum large, longer than the corium, reaching the apex of the abdomen (♂) or nearly reaching it (♀), slightly narrowed behind the base, thence slightly amplified; frena short: prostethium furrowed, furrow with moderately elevated margins: feet moderate; tibiæ furrowed: second genital segment in ♂ entirely hidden, only the third genital segment visible (*Horv.*). Differs from *Scotinophara*, Stål, in the shorter rostrum and the gular ring without a tooth on each side: from *Amauropepla*, Stål, in the head not being narrowed forwards before the anteocular sinus, in the tylus being somewhat elevated, and in the rostrum being longer.

123. STORTHECORIS NIGRICEPS, Horvath.

Storthecoris nigriceps, Horv., Wien. Ent. Zeit. ii, p. 297 (1883).

♂, ♀. Fuscous-testaceous, rather densely punctured fuscous: head, pectus and a very large discal patch on venter, black: juga extending distinctly beyond the tylus, gradually a little dilated before the middle, obliquely roundly truncated at the apex: spine of the antenniferous tubercles, robust, straight, obliquely turning outwards and subacute at the tip: the anterior lateral margins of the thorax behind the triangular gular process, very slightly rounded and dilated, the obsolete intramarginal furrow parallel with the margins: the continued median line more or less obsolete on the thorax and three callous basal spots on the scutellum, pallid: scutellum truncated at the apex (♂), or rounded ♀: membrane whitish-hyaline: lateral borders of metastethium and venter broadly yellow-testaceous, punctured black; ventral spiracula and small basal spots on the connexivum, black; rostrum, antennæ and feet, yellow-testaceous, variegated with black, sparingly greyish-pilose: third joint of the antennæ more than thrice longer than the second (*Horv.*). Long, 7; broad, 4 mill.

Reported from the Himálaya.

Genus AMAUROPEPLA, Stål.

Ofvers. K. V.-A. Förh. p. 502 (1867); En. Hem. v, p. 34 (1876).

Differs from *Scotinophara* in having the head gradually narrowed forwards before the anteocular sinus: the anterior lateral margins of the thorax rounded and denticulate: head somewhat flat: tylus not elevated.

124. AMAUROPEPLA DENTICULATA, Haglund.

Amauropepla denticulata, Haglund, Stettin. Ent. Zeit. xxix, p. 151 (1868): Stål, En. Hem. v, p. 34 (1876).

♂. Oblong, above lurid, beneath black-fuscous, entirely densely punctured black; rostrum and feet sordid flavescent; membrane and wings whitish-hyaline, external margin of membrane hardly flavescent; thorax with the sides serrate and lateral angles boradly emarginate. Head with tylus shorter than the juga which are hiscent at the apex; bucculæ elevated: eyes very prominent, almost pedunculate: ocelli placed a little behind an imaginary line drawn between the base of the eyes, twice more distant from each other than from the eyes: antenniferous tubercles externally spinose, entirely visible from above: first and second joints of the antennæ subequal, one half the length of the third: rostrum short, reaching the middle between the anterior and intermediate coxæ: sides of thorax slightly rounded, irregularly serrate or denticulate, transversely impressed on the disc; posterior margin, straight: scutellum large, reaching apex of abdomen, spathulate, with the sides sinuate, broadly rounded at the apex; frena short: abdomen densely punctured; minute tubercles behind the spiracula less distinct: feet moderate, tibiæ hardly sulcate externally towards the apex (*Haglund*). Long, 10; broad, 5; exp. hemi. 18 mill.

Reported from Rangoon.

Genus MELANOPHARA, Stål.

Ofvers. K. V.-A. Förh. p. 503 (1867); p. 152 (1868); En. Hem. v, p. 34 (1876).

Differs from *Aspidestrophus*, Stål, in having the head very slightly convex behind the middle, somewhat concave towards the apex, margins acute; rostrum reaching the intermediate coxæ; body oval.

MELANOPHARA DENTATA, Haglund.

Melanophara dentata, Haglund, Stettin Ent. Zeit. xxix, p. 152 (1868): Stål, En. Hem. v, p. 34 (1876).

♀. Black, opaque, above finely, remotely, abdomen more densely, punctured; briefly, palely pubescent; rostrum and tarsi, obscurely rufescent; thorax anteriorly elevated and marked with gyrated smooth impressions; impressed transversely in the middle; anterior angles with a very minute tooth, sides rounded and furnished with four small teeth, lateral angles with a large acute spine and behind it slightly emarginate. Head anteriorly rounded, very slightly emarginate; juga longer than the tylus, contiguous: ocelli situate behind an imaginary line drawn between the base of the eyes, twice more distant from each other than from the eyes: antenniferous tubercles broad, externally strongly dentate, altogether distinct from above: first and second joints of the antennæ equal, one half the length of the third: bucculæ much elevated, continued through: rostrum reaching the intermediate coxæ, third and fourth joints equally long, second subequal to them: thorax anteriorly with less distinct, smooth, gyrated or tortuous impressions; posterior margin, straight: scutellum broad, rounded at the apex, not reaching the apex of the abdomen; sides before the middle slightly sinuated; frena not reaching the middle; membrane slightly fuscescent: spiracula and minute tubercles behind the spiracula, distinct: tibiæ externally distinctly sulcate (*Haglund*). Long, barely 9; broad, 4½ mill.

Reported from Rangoon.

Genus ASPIDESTROPHUS, Stål.

Ofvers. K. V.-A. Förh., xi, p. 232 (1854): Freg. Eug. Resa, Ins., Hem., p. 219 (1859); Ofvers. l. c., p. 503 (1867); En. Hem. v, p. 34 (1876).

Body somewhat broadly subovate, subpubescent: head subquadrate, rather convex, somewhat deflexed towards the apex, spinose on both sides before the eyes; juga scarcely longer than the tylus, obliquely truncate or sinuately truncate outwards at the apex, margins obtuse: rostrum reaching the posterior coxæ; antennæ as long as the head and thorax together: the thorax transversely, a little sinuate anteriorly, subtruncate posteriorly, sides slightly rounded, crenated: scutellum as long as the abdomen but half its breadth, slightly sinuate on both sides towards the base, broadly rounded at the apex: feet moderate, basal and apical joints of tarsi equal in length, the intermediate very small (*Stål*).

126. ASPIDESTROPHUS MORIO, Stål.

Aspidestrophus morio, Stål, Ofvers. K. V.-A. Förh. p. 232 (1854); Freg. Eug. Resa, Ins, Hem. p. 219, t. 3, f. 1 (1859); Vollenhoven, Faune Ent. l'Arch. Indo-Néer. i, p. 43 (1863); Walker, Cat. Het. i, p. 71 (1867). Stål, En. Hem. v, p. 34 (1876); Distant, A. M. N. H. (5 s.) iii, p. 44 (1879).

Aspidestrophus lineola, Vollenhoven, l. c. p. 44, t. 3, f. 10 (1863): Walker, l. c. iii, p. 521 (1868).

Black-piceous, roughly punctured, sordid ochraceous pubescent and silky; an almost apical ring on the femora and the tarsi, sordid yellow-testaceous (*Stål*). Long, $7\frac{1}{2}$; broad, $4\frac{3}{4}$ mill.

♂. Head square, rounded in front; head and pronotum punctured, of a very deep brown with a yellowish villosity, rather close: antennæ of the same colour: scutellum contracted obliquely on each side towards the base, pitchy brown, with a spare punctuation on the disc, closer towards the borders, weakly yellowish pilose: hemelytra of the same colour, rather strongly punctured, with some short, yellowish hairs towards the base of the costal border: beneath of a pitchy colour, the sternum with a yellowish villosity; abdomen punctured, sparingly pilose; each segment has a small round tubercle behind each stigma: feet of the same colour as the body, except a small patch beneath almost at the end of the femora, and the tarsi which are yellowish-white. (*Voll.*). Long, $7\frac{1}{2}$ mill.

Reported from Java, Borneo, Sumatra, Assam.

A. lineola, Voll. is smaller (6 mill.), of an almost black brown or black and is not so pubescent. A small line on the pronotum, a semicircular subapical spot on the femora and apex of antennæ, yellow.

Div. HALYARIA, Stål.

En. Hem. v, p. 34 (1876) :—Includes *Sciocorides* and *Halydes*, pt., Am. & Serv., Hist. Nat. Ins. Hém. p. 118, 103 (1843) :—*Sciocoridæ* and *Halydidæ*, Dallas, List Hem. i, p. 130, 150 (1851).

Venter anteriorly on both sides with a short transversely rugose or strigose streak or with the venter furrowed : head long, rostrum reaching behind the last coxæ : antennæ remote from the eyes, third joint of the rostrum much longer than the fourth ; eyes strongly prominulous.

Genus MECIDEA, Dallas.

List Hem. i, p. 139 (1851) ; Stål, Hem. Afric. i, p. 79, 132 (1864) ; Ofvers. K. V.-A. Förh. p. 58 (1872) ; En. Hem. v, p. 34, 37 (1876) : Walker, Cat. Het. i, p. 179 (1867). Includes *Ceratanlax*, Signoret, A. S. E. F. (2 s.), ix, p. 335 (1851).

Body somewhat elongate, somewhat depressed : head oblong-triangular, produced, somewhat convex, juga much longer than the tylus, anteriorly gradually narrowed and converging, or somewhat hiscent, lateral margins of the head not flattened ; antenniferous tubercles entirely visible from above : bucculæ slightly elevated : eyes globose, rather prominulous ; ocelli large, on a line with the base of the eyes : rostrum reaching the metasternum, inserted towards the apex of the head, second joint much longer than the third, about as long as the two apical taken together, third longer than the fourth : antennæ 5-jointed, stoutish, gradually stouter towards the base, first joint not reaching the apex of the head, second joint as long as or longer than the others, three-cornered and somewhat thickened towards the base, fourth joint longer than the fifth : anterior lateral margins of thorax obtuse, somewhat entire or very obsoletely crenulated, slightly sinuated : scutellum triangular, much narrowed at the apex, frena extended to a distance beyond the middle : hemelytra scarcely narrower than the abdomen ; membrane with simple veins : mesosternum somewhat furrowed : feet moderate, femora unarmed at the apex ; tibiæ somewhat furrowed ; tarsi 3-jointed (*Stål.*).

127. MECIDEA INDICA, Dallas.

Mecidea indica, Dallas, List Hem. i, p. 139, t. 3, f. 3 (1851) ; Trans. Ent. Soc. (n. s.) ii, p. 9 (1852) ; Walker, Cat. Het. i, p. 179 (1851) : Stål, En. Hem. v, p. 38 (1876).

♀. Pale yellow, thickly and finely punctured ; eyes black : scutellum very long : membrane transparent, whitish : ventral stigmata brown : rostrum with the tip black : antennæ with the second joint very long, more than twice the length of the third, dilated towards the base ; 4-5 joints shorter than the second, but longer than the third ; fourth longer than the fifth: antenniferous tubercles spinous on the outside (*Dallas*). Long, 10½ mill.

Reported from Bengal.

Genus DALPADA, Am. & Serv.

Hist. Nat. Ins. Hém. p. 105 (1843); Dallas, List Hom. i, p. 153 (1851): Stål, Hem. Afric. i, p. 80, 101 (1864): Walker, Cat. Het. i, p. 218 (1867): Stål, Ofvers. K. V.-A. Förh. p. 508 (1867); En. Hem. v, p. 36, 43 (1876). Includes *Udana*, Walker, l. c. iii, p. 549 (1863).

Body oval or ovate: head scarcely or only very slightly convex: juga more or less distinctly sinuated at the apex outwards or obliquely truncated: bucculæ reaching the base of the head, angulated anteriorly, antennæ 5-jointed, slender, the first joint not or only very slightly extending beyond the juga, not longer than the marginal space of the head lying between the eyes and the place of insertion of the antennæ: eyes globose rather prominulous; ocelli in a line with the base of the eyes: rostrum extending a little beyond the last pair of feet, first joint not or only slightly extended beyond the bucculæ: anterior lateral margins of the thorax crenulated: membrane with about six simple, longitudinal veins: mesosternum carinated: venter slightly sulcated at the base: feet somewhat long; tibiæ broadly furrowed above, first pair sometimes dilated (*Stål*).

128. DALPADA OCULATA, Fabricius.

Cimex oculatus, Fabr., Syst. Ent. p. 703 (1775); Spec. Ins. ii, p. 347 (1781); Mant. Ins. ii, p. 285 (1787); Ent. Syst. iv, p. 99 (1794).

Halys oculata, Fabr., Syst. Rhyng. p. 181 (1803).

Dalpada aspersa, Ellenr., Nat. Tijdssk. v. Ned. Ind. xxiv, p. 140, f. 8 (1862).

Dalpada oculata, Dallas, List Hom. i, p. 184 (1851); Walker, Cat. Het. i, p. 218 (1867); Stål, Hem. Fabr. i, p. 22 (1868); En. Hem. v, p. 43 (1876); Distant, J. A. S. B. xlviii (2), p. 37 (1879); A. M. N. H. (5 s.) iii, p. 45 (1879).

Grey: antennæ usually as long as the body, fuscous, with two white rings; head, fuscous, immaculate; pronotum greyish or variegated fuscous-testaceous, furnished posteriorly with a small, obtuse prominence; scutellum paler at the apex and at the base, on both sides with a very glabrous yellow spot: hemelytra concolorous; wings black: beneath yellow with a lateral line, fuscous, and the margins of the abdomen variegated fuscous and ferruginous: femora scabrous, pallid, black at the apex; tibiæ black (annulated yellow), first pair dilated at the apex; tarsi pallid, black at the apex, four posterior feet pale, geniculæ black (*Fabr.*). Stål observes that the specimens usually found in collections are clouded with fuscous-æneous above, a large smooth spot at the basal angles and nearly the third apical part of the scutellum, flavescent, and the anterior tibiæ are dilated. Long, 15—18 mill.

Reported from China, Siam, Cambodia, Tenasserim, Assam, Silhat Malacca, Penang, Java, Borneo, Sumatra, Celebes, Bouru, Philippines. The Indian Museum has specimens from Sikkim, Assam, Arakan, Tavoy.

129. DALPADA VERSICOLOR, Herr. Schäffer.

Halys versicolor, Herr. Schäff. Wanz. Ins. v, p. 76, t. 169 f. 520 (1839); vii, p. 60 (1844).

Dalpada versicolor, Dallas, List Hom. i, p. 185 (1851); Walker, Cat. Het. i, p. 220 (1876); Stål, En. Hem. v, p. 43 (1876): Lethierry, Ann. Mus. Gen. xviii, p. 648 (1883).

Yellow-fuscous, variegated with bronze or steel-green patches: head elongate, tylus extending beyond the juga which form outwards two obtuse angles: eyes large: antennæ slender: sides of pronotum weakly serrated anteriorly, angles acute: two subminiaceous spots at base of scutellum of which the apex is long and slender; membrane with eight veins of which the outer on each side is indistinct: margin of abdomen yellow-ochreous with steel-green spots: beneath pale orange with greenish pulverulent outer border and a black longitudinal spot posteriorly. Long, 14 mill.

Reported from Java, India, Burma.

130. DALPADA CLAVATA, Fabricius.

Cimex clavatus, Fabr., Ent. Syst. Suppt. p. 532 (1798).

Halys clavata, Fabr., Syst. Rhyng. p. 181 (1803).

Dalpada clavata, Dallas, List Hom. i, p. 184 (1851); Walker, Cat. Het. i, p. 219 (1867). Stål, Hem. Fabr. i, p. 22 (1868); En. Hem. v, p. 43 (1876); Distant, A. M. N. H. (5 s.) iii, p. 45 (1879).

Head porrect, unidentate on both sides: thorax not serrated but armed on both sides with a small dull-black clavate protuberance, two white dots at the apex: scutellum cinereous at the apex: hemelytra spotted fuscous: abdomen flavescent, margin black, spotted yellow (*Fabr.*).

Closely allied to *D. versicolor*, H. S., head a little longer, lateral angles of pronotum somewhat more obtuse, more thickened and flexed upwards; without the somewhat large, smooth, spot on the basal angles of the scutellum but at the base near the angles, a small smooth spot; dots more fuscous, less brassy (*Stål*). Long, 15—16 mill.

Reported from Tranquebar, Assam.

131. DALPADA PILICORNIS, Stål.

Dalpada pilicornis, Stål, En. Hem. v, p. 44 (1876).

♂. **Stramineous**; head, pronotum, hemelytra, and **pectus**, **distinct-**

ly and irregularly punctured brassy, an indistinct median streak and the apex of the lateral angles of the pronotum less densely punctured, the lateral angles of the pronotum rather prominulous, neither tumid nor rugose; scutellum with a somewhat large, smooth, oval spot on the basal angles, third apical part and discoidal streak somewhat smooth, sparingly punctured; membrane greyish, veins fuscous: connexivum aeneous, segments banded with yellow; venter testaceous, sparingly punctured fuscous-aeneous, anteriorly subsulcate, extreme angles of segments, aeneous; antennæ, rostrum and feet pilose, the feet sprinkled with fuscous; second joint of the antennæ shorter than the third: rostrum somewhat extended beyond the last coxæ; tylus and juga equally long. ♂ with the genital segment strongly tri-impressed, costate between the impressions (*Stål*). Long, 10; broad, 5 mill.

Reported from the Nilgiris (Madras).

132. DALPADA CONCINNA, Westwood.

Halys concinna, Westwood, Hope, Cat. Hem. i, p. 23 (1837).
Dalpada concinna, Stål, En. Hem. v, p. 44 (1876.)

Greyish-luteous, punctured with fuscous: two black lines between the eyes; thorax anteriorly serrate; posterior angles prominulous, black; basal angles of scutellum pallid; membrane hyaline, longitudinal veins fuscous, with some oblong dots scattered between; feet concolorous: sides of abdomen with black spots, a single small white spot in the middle. (*Westw.*). Long, body 14—14½ mill.

Reported from China, India. Dallas unites this with *D. clavata*, Fabr.

133. DALPADA NIGRICOLLIS, Westwood.

Halys nigricollis, West:, Hope, Cat. Hem. i, p. 22 (1837) (♂).
Halys obscura, West. l. c. p. 22 (♀): Dallas, l. c. p. 184 (1851).
Dalpada nigricollis, Dallas, List Hem. i, p. 184 (1851); Walker, Cat. Het., i, p. 219 (1867). Stål, En. Hem. v, p. 44 (1876).

♀. Greyish luteous, everywhere punctured with brassy-black: slender, longitudinal, median line on the pronotum and four minute dots, luteous; sides of pronotum hardly serrate, posterior angles subprominulous; basal angles of scutellum, whitish: membrane pallid, with six fuscous longitudinal veins and the same number of intermediate longitudinal fuscous dots: feet luteous, dotted black: base of fourth and fifth joints of the antennæ, white. (*Westw.*). Long, 17—18 mill.

Reported from Bengal.

♂. Smaller than the ♀: the head and the thorax, blackish: antennæ fuscous, second joint incurved; sides of thorax entire, posterior angles subacute, prominulous, black: scutellum fuscous, punctured luteous, basal angles luteous; membrane whitish, the longitudinal veins slender with several fuscous dots strewed between them: abdomen fulvous with a broad lateral band fuscous, feet luteous, punctured fuscous (*Westw.*). Long, 12—13 mill.

Reported from Nepál, India.

134. DALPADA AFFINIS, Dallas.

Dalpada affinis, Dallas, List Hem. i, p. 185 (1851); Walker, Cat. Het. i, p. 219 (1867); Stål, En. Hem. v, p. 44 (1876).

♀. Closely allied to *D. nigricollis*, Westw.; body broader, head longer, lateral angles of pronotum tuberculose, large, obtuse, whitish at the apex: scutellum immaculate at the base, somewhat broad at the apex: membrane fuscescent, veins more obscure: sides of the abdomen variegated with fulvous and black: antennæ fulvous, two last joints, fuscous (*Westw.*). Long, 17—18 mill.

Reported from N. India.

135. DALPADA VARIA, Dallas.

Dalpada varia, Dallas, List Hem. i, p. 185 (1851); Walker, Cat. Het. i, p. 220 (1867); Stål, En. Hem. v, p. 45 (1876); Distant, J. A. S. B. xlviii, (2) p. 37 (1879); A. M. N. H. (5 s.) iii, p. 45 (1879).

♂. Greyish-testaceous, punctured black; lateral angles of the pronotum subtuberculate; head, pronotum, scutellum, corium and margins of abdomen, variegated greenish-aeneous: scutellum with two whitish spots at the base; corium rufescent at the apex; membrane fuscescent, subhyaline, veins fuscous and the basal spot black: abdomen beneath, testaceous, sides punctured and subapical spot, black: feet and rostrum testaceous (*Westw.*). Long, 18-18½ mill.

Reported from Silhat, Assam: when the pubescence is removed the apex of the scutellum is broadly luteous. The Indian museum has a specimen from Tenasserim.

136. DALPADA ALTERNANS, Westwood.

Halys alternans, Westwood, Hope, Cat. i, p. 22 (1837).

Closely allied to *D. nigricollis* (♀), Westw.: differs especially in having the sides of the pronotum almost straight, oblique, posterior angles not prominulous: membrane with six longitudinal veins, fuscous, extended almost to the apex, the three internal connected at the base; internal space fuscous; feet with fuscous and luteous rings: sides of abdomen with abbreviated transverse, black striæ (*Westw.*). Long, 16—17 mill.

Reported from Bengal.

XIII.—*Natural History Notes from H. M.'s Indian Marine Survey Steamer* 'Investigator,' *Commander* ALFRED CARPENTER, R. N., *Commanding. No. 4. Description of a new Species of* Crustacea *belonging to the Brachyurous Family* Raninidæ.—*By* J. WOOD-MASON, ESQ., *Superintendent of the Indian Museum, and Professor of Comparative Anatomy and Zoology in the Medical College of Bengal, Calcutta.*

[Received and Read August 5th, 1885.]

(With Plate I.)

LYREIDUS CHANNERI, n. sp.

Proc. Asiat. Soc. Bengal, August 1885, p. 104.

♂. Carapace transversely moderately convex, longitudinally bluntly carinate and slightly arched from near the posterior margin almost to the level of the spines marking the commencement of the antero-lateral margins, from which level to the end of the rostrum it is slightly concave; its antero-lateral margins armed with two pairs of long slender and acute outwardly and forwardly directed spines, of which the posterior are nearly twice the length of the anterior pair (the left one of which has been broken off early in life and is now only represented by a tubercular scar): its sides parallel from the larger pair of spines backwards to the insertion of the chelipeds, whence they gradually and regularly converge to the rounded angles of the concave-truncate posterior margin; and rapidly convergent from the same pair of spines forwards to about the level of the middle of the 3rd joint of the external maxillipeds, whence they suddenly run parallel to, or slightly divergent from, one another to the ends of the extraorbital spines. The rostrum is semi-oval, or, in other words, has the form of a triangle with the apex rounded and the opposite sides slightly arched, and, like the eye-peduncles, is surpassed by the long and acuminate extra-orbital spines.

Immediately in front of the two small crescentic muscular impressions near the middle of its length, the carapace is crossed by a faint depression, interrupted by the median carina and continued on the sides, passing immediately in front of the junction of the finely beaded postero-lateral lines with the *linea anomurica* some distance to the rear of the hinder pair of antero lateral spines, and deepening as it goes, to the buccal frame; in front of this depression the puncture of the surface is much coarser and thicker than behind it. The antero-lateral margin is finely granulated and, with the contiguous subhepatic and anterior pleural regions, slightly hairy. Two faint depressions, marking out a cardiac region, pass off from the posterior ends of the crescentic impressions, extending rather more than half way to the posterior margin, and slightly converging as they go; and two oblique elevations, situated about midway between the median carina and the postero-lateral margins, with which they are parallel, are present on the posterior third of the carapace.

The eye-peduncles have the same form as those of *L. tridentatus*, and reach nearly to the level of the end of the rostrum, but the eyes they carry are in process of reduction to the condition of those of so many Reptant and Brachyurous Crustacea that inhabit the muddy depths of the sea, and, moreover, are unequally reduced on the two sides of the body, the left being represented by an oval and convex obsoletely faceted, thick, and opaque-yellow cornea, situated, as in the typical species of the genus, on the outer apex of the peduncles, with the subjacent pigment showing through the integument at its base as a dark lead-coloured circumferential band, while all that is to be seen in the corresponding part of the right eye is a smooth and very slightly convex area marked out by the transparence of the pigment of the subjacent ophthalmic tract.

The propodite of the chelipeds is armed below with two acute triangular spines, of which the distal is twice the size of the proximal; its low dorsal crest ends distally in a small tooth; the cutting process of its inner edge is divided into five irregular tooth-like lobules; and its tip is strongly hooked or incurved. The cutting edge of the dactylopodite is obsoletely two-toothed. The only armature of the carpopodite is a single long and acute spine, answering to the distal of the two in *L. tridentatus*. The meropodite bears a sharp spinule in the place of the tubercle seen in the typical species. The dactyli of the 1st and 2nd pairs of legs are shorter and broader, particularly those of the former, and the crests of the two preceding joints in the former also are all more lamellar, the dorsal ones being in addition distally produced to sharp teeth. No direct comparison of the 3rd pair of legs in the two species is possible, as these limbs are wanting in the only specimen of the Japanese form available for comparision, but, judging from DeHaan's figure, the two last joints would appear to be much more expanded in the Indian one. All the legs are slenderer.

The third and fourth abdominal terga each bear a very sharp recurved spine in the middle line.

Dr. Giles notes that the animal was in life, " except a little brown tint in front, of a uniform salmon colour;" and in the spirit-specimen all the upper surface of the carapace in front of the transverse impression, with the exception of the lateral spines, is still darker coloured than the rest of the body.

The unique example from which the foregoing description has been drawn up measures :—

	millims.
Length of carapace from tip of rostrum to posterior margin	25.0
,, ,, ,, ,, to the middle of a straight line joining the bases of the posterior spines	8.5
Length of carapace from the posterior margin to the same straight line	16.5
Breadth of carapace across the parallel-sided part.................	14.3
Breadth of head between tips of extra-orbital spines.................	6.0
Distance between tips of posterior antero-lateral spines	18.0
Length of posterior antero-lateral spines	5.0
,, ,, anterior antero-lateral ,, ...	3.0
,, ,, genital appendages	5.5
,, ,, rostrum, measured from a straight line drawn tangentially to the bottom of the supra-obital emarginations,	2.0
,, ,, extra-orbital angles, measured from the same straight line, ...	3.4

This interesting brachyuran may at once be distinguished from either of the three previously described species of its genus (*L. tridentatus*, DeHaan, Faun. Jap. Crust. 1850, p. 138, tab. XXXV, fig. 6, ♂, *L. elongatus*, Miers, Proc. Zool. Soc. Lond. 1879, p. 45, both from the seas of Japan, and *L. bairdii*, S. I. Smith, Proc. U. S. Nat. Hist. Mus. 1881, III, p. 420, from 100 fathoms, off the South Coast of New England) by the conspicuous armature of its carapace, by its bispinose abdomen, and by its partially aborted eyes.

A single male only of it was dredged up in the trawl from a depth of 405 to 285 fathoms with a bottom temperature of 48° to 50′ Fahr. in the 'swatch-of-no-ground,' a deep and narrow valley running northwards from the floor of the Bay of Bengal to within a short distance of the shoals lying off the conjoined mouths of the Ganges and Brahmaputra, in Lat. 21° 6′ 30″ N., Long. 89° 20′ E.

Explanation of Plate I.

Fig. 1. *Lyreidus channeri*, W.-M., ♂. Natural Size.

,, 2. Orbital, antennary, and buccal view. × 2.

,, 3. Four terminal somites of abdomen, seen from below as they lie closely applied against the underside of the cephalothorax. × 3.

,, 4. Dorsal view (to the right) of the abdomen, with side view (to the left) of its spinigerous 3rd and 4th terga. × 3.

,, 5, 5*a*. Outline views from above, or optic sections in the plane of the fringing setæ, of the left and right eye-peduncles respectively, to show (*a.*) the setæ that fringe their two margins up to the corneal membrane on each side; (*b.*) the thickness and the relative development of the cornea, which, opaque in both eyes, exhibits an obscure and degenerate faceting in the left, but is devoid of all traces of facets in the right, the shorter and the broader of the two; and (*c.*) the relative amount of pigment, represented by the dark shading. × 12. Zeiss' a*. Oc. 2. Abbe camera.

Fig. 6. The right chela. × 3.

" 7. *Lyreidus stenops*, n. sp., ♀. Dorsal view (to the right) of the abdomen, with side view (to the left) of its spinigerous 4th tergum. × 2.

" 8. The carapace of the same in outline. Natural Size.

This species may at once be distinguished from its congeners by its narrow metope, its unarmed carapace, and its decumbent abdominal spine. A single specimen of it, with a male and two females of another species identical with the specimen from Japan referred in the above description to *L. 3-dentatus*, has been received by me from Hongkong from Brigade-Surgeon Hungerford, since this paper was written.

XIV.—*Natural History Notes from H. M.'s Indian Marine Survey Steamer* 'Investigator,' *Commander* ALFRED CARPENTER, R. N., *Commanding. No.* 5. *On some Nodular Stones obtained by trawling off Colombo in* 675 *Fathoms of Water.—By* E. J. JONES, A. R. S. M., *Geological Survey of India.*

[Received February 2nd;—Read March 2nd, 1887.]

(With Plate II.)

These nodules were forwarded to the Superintendent of the Indian Museum, and by him passed on to the Director of the Geological Survey, by whom they were subsequently entrusted to me for examination.

The results of this investigation, though owing to want of time incomplete, are, as will be seen, of considerable interest; and I hope at some future time to be able to go into the subject more fully.

The nodules were obtained during a trawling operation off Colombo in water of 675 fathoms, and are stated to have been found associated with sand and mud, which formed a hard calcareous crust at the bottom of the sea, and a small quantity of which was forwarded with the specimens.

The stones are irregularly rounded, and vary in shape from almost spherical to roughly cylindrical with rounded ends. The specimens received varied in size from 1—4 inches in length and 1¼—¾ inch in thickness. Externally, they are rough and mostly have one or two small excrescences of the size of a pin's head, and a few small pittings of about the same size; the colour is dirty light grey.

On breaking them open, the fractured surface has much the appearance of an ordinary slate without the cleavage, and is of a much darker colour than the exterior. Running along the central line of a long cylindrical one which I broke open, there is a narrow vein of a brownish colour.

A microscopic examination of a thin slice shewed merely a confused mass of aggregates resembling in their structure that of sphærulites, such as occur in the so-called sphærulitic lavas, with the remains of Foraminifera and Radiolaria disseminated throughout the mass. With ordinary light, little is to be seen except more or less radiating fibrous aggregates, but, as soon as the section is observed between crossed Nicol's prisms, the whole field is seen to be covered with little dark crosses with their limbs parallel to the planes of the prisms, and, on revolving the stage, the limbs of the crosses keep the same orientation whilst the section revolves.

It is when thus observed that the aggregates are seen to be entirely distinct from one another, as each cross keeps to its own aggregate, and the crosses do not overlap; so that, by revolving the stage, the limit of each aggregate can be determined by tracing the path of the outer end of one of the limbs of the crosses.

In the volcanic rocks in which this structure is known, it appears to be due to incipient crystallization in a glassy mass; and at first it might be supposed that these masses were of igneous origin. This idea, however, is untenable on account of the remains of Foraminifera (of several species, the most easily recognised of which are the globigerinæ) and Radiolaria which are sparsely scattered through the mass and, in some cases, enclose a sphærulitic aggregate.

An indeterminate greenish substance, which probably consists of glauconite, is also seen scattered through the mass.

The only difference that can be detected between the central vein and the portion between it and the exterior is that the aggregates in the central vein are much larger and the colour brown instead of green, and that it is unacted on by hydrochloric acid, which dissolves out some calcic carbonate from the other portion.

As mentioned by Mr. Daly in his letter forwarding the nodules, these are very heavy, having a sp. gr. of 3·77 at a temperature of 30° C. as against water of 4° C.

A qualitative analysis shewed the nodules to consist in great part of baric sulphate together with small quantities of calcic and strontic sulphates, small quantities of calcic and magnesic phosphates, aluminic silicate, calcic carbonate, and traces of iron, sodium, and manganese.

Not having the time to devote to a complete quantitative analysis, I made, in order to arrive at an approximate estimate of the proportion of baric sulphate present, a determination of the sulphuric acid. An average sample from two of the nodules powdered and dried at 100° C. gave 82·5 °/₀ of baric sulphate, the whole SO_2Ho_2 being calculated as SO_2Bao''.

This result is, however, of course too high, as a small quantity of the SO_2Ho_2 is combined with Ca. and Sr. in the form of calcic and strontic sulphates, though, from the results of the qualitative analysis, it is probably not much too high; and we may, I think, safely take 75°/₀ as the percentage of baric sulphate present.

In order to see whether the material was derived from the mud in which the nodules occur, and which also contained Foraminifera, I made a qualitative analysis of the mud, and found it to consist mainly of aluminic silicate, with small quantities of calcic carbonate, some iron, and a trace of manganese; there was also a trace of an alkaline earth which was not removed by boiling with hydrochloric acid and subsequent washing, but this, on spectroscopic examination, shewed itself to be lime.

In spite of the negative result of the analysis of the mud, I am inclined to think, from the presence of the Foraminifera both in the mud and enclosed in the nodules, that the latter have been formed at the bottom of the sea either at the spot where they were found or at no great distance therefrom, though it is difficult to imagine how the material was obtained, but it is possible that a careful analysis of a larger quantity of the mud would reveal a trace of Barium, for sea-water contains a slight trace of this element.

I cannot at present call to mind any instance of sphærulitic structure occurring without the aid of heat.

In volcanic lavas and in artificial glasses, it may be regarded as concretionary, or as resulting from incipient crystallisation or devitrification around certain points or nuclei. The nuclei when they exist consist either of a granule or a minute crystal or crystallite, but most commonly no nucleus is discernible.*

In this case, however, it would seem, that it must be due to slow segregative action; and, baric sulphate being very slightly soluble in water, the deposition would be very slow and may have been to some extent crystalline, at any rate sufficiently so to produce the same effect as incipient crystallisation from a glassy mass.

The execution of the accompanying plate has been kindly superintended by Mr. J. Wood-Mason.

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* Rutley's Study of Rocks, p. 183.

EXPLANATION OF PLATE II.

Fig. 1, 2. The external appearance, natural size, of some of the nodules.

Fig. 3. A thin slice treated with hydrochloric acid and seen between crossed Nicol's prisms; shewing the dark crosses and radiating structure of the aggregates.

Fig. 4. A thin slice shewing some of the enclosed Foraminifera as seen by ordinary light; from a microphotograph (Smith and Beck's 1½″ obj.) taken in the Biological Laboratory of the Indian Museum, Calcutta.

XV.—*Natural History Notes from H. M.'s Indian Marine Survey Steamer* 'Investigator', *Commander* ALFRED CARPENTER, R. N., *Commanding. No. 6. On Six new Amphipods from the Bay of Bengal.—By* G. M. GILES, M. B., F. R. C. S., *Surgeon-Naturalist to the Marine Survey.*

[Received and Read March 2nd, 1887.].

(With Plates III—VIII.)

CONTENTS.

§ 1. A description of two new Species (i. *Phronima bucephala* and ii. *Phronimella hippocephala*) of the Amphipod Family *Phronimidæ*, with some Remarks on the Genera of the Family.
§ 2. *Rhabdosoma investigatoris.*
§ 3. *Amphipronoë longicornuta.*
§ 4. *Lestrigonus bengalensis.*
§ 5. *Eurystheus hirsutus.*

§ 1. *A Description of two new Species of the Amphipod Family* Phronimidæ *with some Remarks on the Genera of the Family.*

The genus *Phronima* of the division *Hyperina* and family *Phronimidæ* is a very limited and peculiar one. The species that belong to it are remarkable for their bizarre form, and for the circumstance that the head is considerably prolonged downwards, like that of a quadruped, in a direction at right angles to the long axis of the body.

The number of joints in the legs appears to be less than the normal seven. This is due, on the one hand, to the coxal plates being fused with the pleuron of each segment, and, on the other, to the circumstance that the dactylopodite is in most instances very small or reduced to a mere rudiment. Spence Bate* gives as a generic character that the 6th thoracic appendage (third pereiopod) has the dactylopodite fused with the propodite. This is, however, I am inclined to believe, an error; arising probably from the want of fresh specimens. Such also appears to be the case not only in the sixth but in the two preceding appendages of one of the species described below. A careful examination, however, of various intermediate examples, furnished by the different appendages of the two species that have come under my notice, has satisfied me that the dactylopodite is neither absent nor fused with the propodite, but is, in such instances, represented by a minute spine-like body articulated to the distal extremity of the propodite, and usually flanked by a pair of tiny hairs, which appear again in a more developed form in the similarly placed "dactyloptera" which Spence Bate (*loc. cit.*) describes on the dactylo-propodital articulation of *P. sedentaria.*

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* Catalogue of Amphipodous Crustacea in the British Museum, p. 316.

Both my species were taken in the drift (surface) net,—the one that has been named *P. bucephala,* off the Mutlah light in a depth of 15 fathoms, the other, *Phronimella hippocephala,* in somewhat shallower water off the mouth of the Dhamrá river on the Orissa Coast. Both are perfectly colourless and transparent, so that most of the internal organs, muscles, &c., can be seen with the greatest facility through the integument. The circumstance of my only having obtained a single specimen of each in the surface-net appears to point to their not being normally surface organisms. While under observation, living in the tube of the net, although perfectly capable of swimming with considerable activity, they yet showed a tendency to sink to the bottom and rest there. For these reasons, it is probable, that their true habitat is the bottom in the localities and depths already mentioned.

In his recent monograph on the *Phronimidæ,** Claus divides the family into two sub-families—the *Phrosininæ* and the *Phroniminæ.* With the first we have nothing to do, as neither of the species to be described can be referred to this subfamily. Of the *Phroniminæ,* he enumerates four genera, of which *Phronima* Latr. is thus defined :—

"Body produced, with much narrowed and elongated last thoracic segment, with 3 pairs of styloid uropods. Head short, but elevated, with much produced vertico-oral axis. In the female the anterior antennæ two-jointed, and posterior antennæ represented by a globularly arched basal joint provided with a short bristle. The mandibular palps are wanting even in the male. Maxillipedes strongly compressed with lanceolate laminæ and a conical "tongue" (Zunge). Both pairs of gnathopoda slender, with weak, apposed subchelæ. The 5th pair of thoracic appendages provided with slender apposed shear-like forceps. Three pairs of gill-sacs on 4th, 5th, and 6th thoracic segments."

Now, the family, so far as it is known, is of such variable character that each new addition to its numbers appears to require a genus to itself; and to the genus, as thus limited, neither of my forms can be said perfectly to agree.

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* Arbeit. aus d. zool. Inst. d. Univ. Wien u. d. zool. Stat. in Triest, 1879, 11, 1.

To the less limited genus of Spence Bate, however, one of them corresponds in every point, but it differs from the genus as defined by Claus in the following points:—1st., in my one female specimen, I can make out no trace whatever of inferior antennæ; 2nd., the subchela of the "5th" (6th) thoracic appendage cannot be said to be slender, the fixed ramus being very stout and almost quadrate; 3rd., there are two extra small gill-sacs on the 2nd and 3rd thoracic segments, a character extremely abnormal, but of the reality of which I carefully satisfied myself. To avoid, however, the necessity of manufacturing a new genus, I describe it as a member of the genus *Phronima*, as defined by Spence Bate, under the name of *P. bucephala.*

With the second of the species to be described the case is different, as it will not fit into any genus, whether the *Phronima* of Spence Bate, or the genera distinguished by Claus, namely, *Phronima, Phronimella, Phronimopsis*, and *Paraphronima.* Of these the species comes nearest to the definition of *Phronimella,* which is thus given by Claus:—

"Body much produced, entirely transparent, with but two pairs of style-shaped uropods, head short, with high-arched upper surface, vertico-oral axis much produced. The two front segments united without suture. Mandibular palps wanting even in the male. Tongue (Zunge) of the maxillipedes reduced to a wart-like excrescence. Both pairs of gnathopods slender with weak apposed subchelæ. The third pair of thoracic appendages somewhat smaller, the fourth much produced. The fifth pair of legs with a much produced apposed pair of subchelæ. Three pairs of gill-sacs on the 4th, 5th, and 6th thoracic segments."

With this definition, the specimen agrees in the very important detail of possessing but two pairs of style-shaped uropods, and in nearly every other item save in this that, in our species, the "3rd" (4th) thoracic appendages have the unfortunate peculiarity of being the longest and almost the largest of the whole series, instead of being smaller. A minor difference is that the two first thoracic segments, although united, shew signs of a short, but perfectly distinct, suture between their pleura.

On this account, one is reduced to the alternatives of either widening the range of *Phronimella* by cutting out the character referring to the third thoracic agpendage, or of making a new genus. The making of new genera is an expedient which should, I take it, be avoided whenever possible, so that I prefer to adopt the former alternative and to describe the species as *Phronimella hippocephala.*

I will now proceed to the description of the two species.

(i.) Phronima bucephala, n. sp., Pl. III, Figs. 1 & 2.

Head large, and broad at the top, which is almost completely occupied by the regularly arranged series of components of the apical eyes. These latter, though essentially paired organs, very nearly blend in the middle line, so that only a small space in that situation is unoccupied by their visual cones. The dorsal aspect of the head forms a large, transversely oval shield, which is separated from the anterior and lateral surfaces by a distinct horizontal fold. The portion of the head below this forms a truncated cone, tapering from the shield like vertex to the mouth, which is placed on the truncate (ventral) aspect; the whole presenting a curious resemblance to the head of a buffalo, which is further heightened by the circumstance that the maxillipedes, lying along the posterior aspect of the truncated cone, present an outline much like the large fleshy fold behind the lower jaw of that animal. The lateral eyes are placed on the lateral aspect of the head, immediately below the fold that separates the lower truncate portion from the oval apical shield. Their component cones, like those of the apical eyes, are regularly arranged, but are somewhat widely separated, so that there is no true faceting, although a close approach to the true compound faceted eye is attained.

The *antennules* are short and two-jointed; the first joint about a quarter the length of the second, which is of clavate form, and terminated by a tuft of fine, short hairs: the entire length of the organ being a full third less than that of the conical portion of the head.

The *antennæ* are obsolete.

The *gnathites* are somewhat small and are articulated to the inferior or ventral aspect of the truncated cone. Only enough was seen of them to establish their being quite of the usual type, without any salient peculiarities, and that the mandibles are unprovided with any appendage. An unfortunate lurch of the ship spilled the portion of the dissection containing them as they were being separated for the purpose of drawing.

The *thorax*, as seen from above, forms with the cephalic shield a pear-shaped body; its five anterior dorsally visible segments being very broad, the penultimate tapering rapidly, and the last being very long and narrow. The first two are short and hard to distinguish from each other.

All the *thoracic appendages*, with the exception of the anterior gnathopoda, are provided with branchial sacs, but the last two of these greatly exceed the rest in size. 1st gnathopod about one-sixth the length of the body. The dactylopodite very minute and claw-shaped, its articulation with the propodite flanked by a pair of minute flattened hair-like bodies. The propodite is simple, slightly falciform, its posterior border fringed with fine, short, stiff setæ. It forms, in conjunction with the prolonged postero-inferior angle of the carpopodite, a somewhat incomplete subchelæ. The meropodite and ischiopodite are short and triangular, and the basipodite is stout and cylindrical, forming more than a third of the length of the appendage. The 3rd thoracic appendage, or 2nd gnathopod, is of generally similar form to the preceding, but is longer and slighter, equalling a fourth of the whole body length. The subchela, too, is even less perfect, the prolonged postero-inferior angle of the carpopodite amounting to little more than a stout spine. The 4th and 5th thoracic appendages, subequal and closely resembling each other, just equal the combined head and thorax in length, the anterior being slightly the longer and stouter. In both, the dactylopodite is minute and claw-like, propodite and carpopodite subequal and cylindrical, but stouter, and a third shorter than the two preceding joints, the ischiopodite short and triangular, and the basipodite long, cylindrical, swelling somewhat at its distal extremity, and forming quite a third of the length of the whole limb. The 6th thoracic appendage is by far the strongest of the series; it is, however, considerably shorter than 3rd and 4th, being as long only as the thorax. The dactylopodite is represented by a mere rudimentary spine. The propodite forms a stout curved claw which, in apposition with the inferior border of the carpopodite, forms a powerful subchela. The carpopodite is triangular, its inferior border being nearly as long as the lateral. The antero-inferior angle is prolonged into a powerful spine, and the inferior border is armed with three dentations, between which are a corresponding number of small, isolated tufts of hairs. The meropodite and ischiopodite are short and quadrangular, and the basipodite, forming fully half the length of the limb, is stout, cylindrical, and strengthened along its posterior border by a narrow buttress. The 7th and 8th thoracic appendages are alike in plan, the former being, however, decidedly the smaller, especially as to the basipodite, which is much longer and stouter in the 8th appendage. In both, the dactylopodites are minute and claw-like, the propodites of an elongated pyriform outline. The carpo- and meropodites cylindrical, the ischiopodites short and triangular, and the basipodites spindle-shaped.

Abdomen narrow, tapering, depressed rather than compressed, the first three segments long, diminishing from before backwards, the first nearly equalling the long last thoracic segment in length, the third being but half its length. The last three together only equal the 2nd in length.

The first three *abdominal appendages* are of the usual amphipod type, the first and third being subequal, the middle one slightly the longest. The last three abdominal appendages are alike in plan, and the fourth is the longest. They consist of a long cylindrical basal joint provided with a pair of lanceolate rami with serrate margins. The penultimate pair are the shortest of the three and the last but little inferior to the fourth in size. The basal joint of the fourth has the appearance of being composed of two joints; such an arrangement is, however, from a morphological point of view, so improbable, that, although it is represented in the drawing, I have hesitated to describe it as such. Both sides, however, appeared alike.

The *telson* appears obsolete.

The unique specimen is certainly a female, but the unlucky accident to the dissection prevented my dissecting out the generative organs.

Its actual length was 5·75 mm.

(ii.) PHRONIMELLA HIPPOCEPHALA, n. sp., Pl. III, Fig. 3.

The second species differs from the first in many important points. Speaking generally, it is, both as to body and limbs, if I may use the expression, a much more lanky species.

The *head* somewhat resembles that of a horse in shape, but the resemblance is not nearly so striking as that of the first species to the head of a bull. It is not so broad at the top, and no fold surrounds it; so that the appearance of a cephalic shield is not produced: its dorsal aspect is covered with a large, widely separated pair of apical eyes. The lateral eyes are situated low down laterally, of medium size, and of the same structure as in the first species.

Both *antennules* and *antennæ* are present; the former, much the larger, consist of a three-jointed peduncle and a flagellum of eight or ten short segments, total length equal to a third of the body exclusive of the head. The first two joints of the peduncle are short, while the third, of dilated spindle-shaped form, makes up more than half the length of the organ. Near the distal extremity it is provided with a few short, flattened hairs. The flagellum is quite naked with the exception of one or two small hairs on the last joint.

The *antennæ* are little more than half the length of the *antennules* and consist of a peduncle formed of three short joints and a naked tapering flagellum as long as that of the antennule, the proximal articulations of which are ill-marked.

Being unwilling to destroy my only specimen, the *gnathites* and *maxillipedes* were not closely examined: they appeared to resemble very closely those of the first species.

The *thorax* is long, narrow, depressed rather than compressed, the first two dorsally visible segments scarcely separable. The third has the inferior angle of its pleuron produced into a sort of triangular spine, overlapping the second. The fourth and fifth, of nearly equal length, form the widest portion of the body; the sixth longer and narrower than these; and the last, the longest and narrowest of all, is provided behind with a spine on either side of the middle line and has this posterior border considerably everted, so as to admit of hyperextension of the abdomen on the thorax.

The 5th, 6th, and 7th *thoracic appendages* are provided with branchial sacs, the hindermost being the largest. In the gnathopoda, the coxal extension of the pleura is considerable, and extends well below the level of any of the rest. The gnathopoda are on the same general plan as those of the first species, but are much longer and more slender, and their subchelæ are far less developed, being represented, in the anterior of the two, by a process some distance from the inferior extremity of the carpopodite, and, in the posterior, by a small projection half way along its length (this is if anything somewhat exaggerated in the drawing). The 4th is considerably the longest of all the appendages. It is, however, very slender, both the 5th and 6th exceeding it in stoutness. It equals in length the thorax and first two segments of the abdomen, and to all appearance consists of but five joints, the dactylopodite being represented only as a minute hair-like body. The propodite is very long and tapering, forming nearly a third of the length of the limb. The carpopodite, meropodite, and basipodite are long and cylindrical, and the ischiopodite is short and quadrangular. The 5th closely resembles the preceding, but is shorter than it by the length of the basipodite, the carpopodite being less than half as long as that of the 3rd. The postero-inferior angle of its ischiopodite is prolonged into a spine, and the posterior border of its much stouter basipodite is armed, along the distal half of its posterior border, with three strong serrate spines. The 6th is considerably the stoutest of the series, and equals the thorax and first segment of the abdomen in length. The dactylopodite is represented only by a minute hair-like body, the propodite, long and falciform, the carpopodite, a long flattened body, the opposible inferior border of which is but of small extent, is armed along its anterior border with six powerful serrations, so that the extremity much more resembles the sabre of a *Squilla* than a subchela. The mero- and ischiopodites are short and triangular, each having the anterior border armed with two serrations. The basipodite, cylindrical above, is three-sided below, each border ending in a strong spinous process, in addition to which the anterior border is armed with three stout, and the posterio with two smaller, serrations. The 7th and 8th are alike in all respects, save size, the hinder being the larger. With the exception of the short triangular ischiopodites, all the joints are cylindrical. The longer of the two barely equals the abdomen in length. In both the dactylopodites are minute and hair-like.

The *abdomen* is slightly shorter than the thorax, the segments diminishing in length from before backwards. The anterior extremity of the first segment, where it joins the thorax, is much constricted, the broadest part of the region being across the second segment. The last three segments together barely equal the third in length.

The three anterior *abdominal appendages* are of the usual type, the middle one being the largest and the hindermost, the smallest. The fourth consists of a cylindrical basal joint nearly as long as the third abdominal segment. It is provided with two lanceolate entire-margined rami, the outer of which is slightly the larger. The fifth is represented only by a short bud-like rudiment. The last closely resembles the fourth, but is somewhat shorter, and its rami are equal.

The *telson* is rudimentary.

A single specimen measuring about 7 mm. in length.

§ 2. RHABDOSOMA INVESTIGATORIS, n. sp, Pl. IV.

This species presents a close resemblance to *R. whitei* and *R. armatum*, forms which have recently been demonstrated to be male and female of one species by Claus,* by whom, as also by J. H. Streets,† they are well described. The two must accordingly now stand as *R. armatum* (Milne-Edwards).

After comparing the present species with the above descriptions, I am inclined to think that it is a distinct form, more especially as the animal was obtained, although at some distance from the land, from the shallow muddy water about the Palmyrus shoals. Still, the resemblances are so numerous that the shortest way of describing the new species will be to enumerate the differences from the above quoted descriptions of *R. armatum.*

Two specimens, one male and the other female, were obtained; the latter being that shown in the figure. It is probably an adult, as the brood-pouch, although empty, is well-marked and of considerable size.

The differences, described from the female as the more complete specimen, are as follows.—1. The head is shorter, not equalling (rostrum included) one half the total length of the body. 2. The mandibular palp is longer, exceeding in length considerably the first joint of the inferior antennæ. 3. Spence Bate (*Cat. Amphipodous Crust. Brit. Mus.* 1862) describes *R. whitei* as "having the coxa of first pair of gnathopoda produced to an obtuse point": this is wanting in our species. 4. All three of the authorities agree in describing considerable differences between the 1st and 2nd gnathopoda in size, length, and formation: in the present species these are subequal and very closely resemble each other. 5. Spence Bate describes the pereiopoda (last 5 thoracic appendages) as gradually increasing in length posteriorly, the fourth pair longest, the fifth obsolete. In our form, the third is longer than the fourth, and the fifth, although either obsolete or destroyed in the male, is represented by a club-shaped basipodite in the female. 6. The same writer also gives the last three abdominal appendages as differing considerably in length, the last being the longest, while in our form they are subequal, the first being a trifle the longest.

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* Arbeit. aus d. zool. Inst. d. Univ. Wien. u. d. zool. Stat. Triest, 1879, II. 2.

† Proc. Acad. Sc. Phil., 1878, pp. 287—290.

Length of male 2·5 c. m., of female 4·9 c. m.

The male differs further in the inferior antennæ being much shorter, and the mandibular appendage correspondingly diminished.

I append a table of measurements from Claus of *R. armatum;* and a comparison of the corresponding measurements of the present species in an adjacent column is, I think, alone sufficient to establish the specific distinctness of the two forms. The measurements are in millimeters.

	R. armatum						*R. investigatoris.*	
	♂	♂	♂	♂	♀	♀	♂	♀
Length of rostrum (broken)	15	18	20	36	24	28	4½	10
head..................	6¼	8	8	9	10	11	4¼	8
thorax...............	6¾	9	9	9	9½	11	4	7
3 anterior abd. segs.	7½	9½	9½	10	10	12	5	7
4th abd. seg.	3	4	3¾	2½	3	3½	2⅐	3½
5th & 6th abd. segs.	3½	4½	4¼	3½	4	5	2	3½
telson...............	6	9	8	10	18	23½	3¾	6
1st caudal style	6	8	7½	8	10	11	3¼	5¾
2nd „ „	4½	4½	5½	3	—	4	—	5½
3rd „ „	6	8	7½	9	—	18	—	5½

In the male specimen of our species the rostrum is very much broken, in the female it is nearly complete. The specimens are preserved in the Indian Museum.

§ 3. AMPHIPRONOË LONGICORNUTA, n. sp., Pl. V.

Three specimens of the small amphipodous crustacean to be described below were taken in the drift-net in the clear but shallow water of the Mergui Archipelago.

It probably has its proper habitat at the surface, as it swims easily, though with no great speed. Its most salient peculiarity is the immense length of the rigid 5-jointed antennæ, which are much longer than in any form hitherto described, and are carried folded up and directed obliquely downwards and forwards in front of it.

The total length of the body is 6·5 mm., and the animal is opaque, of a pale pinkish brown tint, and plentifully sprinkled with deep madder-brown pigment spots, which are most numerous on the pleura and coxæ of the thorax, and on the entire surface of the 2nd and 3rd abdominal segments.

It is stoutly built, not markedly compressed.

The *head* is large, its length, depth, and breadth each equalling rather less than $\frac{1}{5}$th the body length; its entire upper and lateral surfaces occupied by the large regularly faceted eyes, and its anterior inferior aspect deeply hollowed for the reception of the antennules and of the first joint of the antennæ.

The *thorax* forms the broadest and deepest part of the body, but its segments are short, so that its entire length is but $\frac{2}{5}$th longer than the head. The coxal plates are united to the pleura, without any very obvious suture, and the first and the last two segments have their terga ankylosed.

The *antennæ* and *antennules* are formed on almost exactly the same plan as those of *Rhabdosoma*. On looking at the latter genus, one is inclined to be led to the conclusion that the curious antennæ have been evolved to enable the animal to reach out beyond the enormously prolonged rostrum and cephalon generally, which latter formation together with its generally slender form certainly suits the attainment of a high rate of speed. The present species, however, demonstrates the danger of such hasty deduction, as we have here the antennæ of even greater proportional length than in *Rhabdosoma*, while the head and body generally are short and stout and the entire plan of its structure is adapted for strength rather than speed.

The *antennules*, when at rest, are almost completely hidden within the depression of the antero-inferior face of the cephalon, the tip of the flagellum only being visible; they consist of a three-jointed peduncle of peculiar form (Fig. 2.) and a three-jointed flagellum (Figs. 2. & 3.). The basal joint is articulated to the recessed surface of the cephalon, close to the middle line, at a point about even with the middle of the eye. The first two joints are short and compressed and quadrate, directed obliquely downwards and forwards; the third joint is much larger, and is much compressed, so that, seen from below, it appears merely slightly clavate, viewed laterally, it is seen to be broad and of falciform outline, curving round, so that its distal border comes to be directed upwards and forwards. Its convex border is thickly clothed with a multitude of very fine, soft, flexible hairs, regularly arranged in distinct, but closely placed, transverse rows. The body of the joint is filled up by a large ganglionic mass, which appears to send off branches to the bases of the hairs. The flagellum (Fig. 3.) is extremely small in proportion to the peduncle, and consists of three joints, subequal in length, compressed, and diminishing progressively in breadth, so that the last joint is cylindrical; the first joint is provided with a circlet of soft clavate or spindle-shaped flattened hairs not so long as, but considerably broader than, those of the distal joint of the peduncles. The second has a similar pair of hairs springing from a depression on its distal aspect, while the last joint, which presents two slight constrictions in its length, is free from hairs, with the exception of three stiff tapering auditory bristles at its extremity. The entire organ is less than a millemeter in length and is so articulated as to be capable of flexion and extension only, no lateral play being practicable.

The *antennæ* take their origin a little behind, but much external to, the antennules, so that their first joint is placed close to the wall of the recess, and, in their habitual posture, they are completely hidden from the outside. The first joint reaches quite to the front of the recess, so that, to the casual observer, the second appears to be the first joint of the appendage, and to take its origin considerably in front of the antennules. The 2nd, 3rd, and 4th joints are carried folded sharply upon one another and the 2nd and 3rd of them are each half as long as the animal exclusive of the last two abdominal segments; the fourth is slightly shorter and the fifth very short: the proportional length of the 5 joints being as 25 : 67 : 67 : 60 : 3; and the whole length of the organ being a little over 9 m.m., or about 1½ times the length of the body. Each joint is thickly clothed with extremely fine short, hairs, too small to be visible except under very high amplification. The musculature of their appendages is peculiar. In the first joint, a pair of powerful muscles, flexor and extensor, are located in its proximal two-thirds, and act by means of two distinct tendons on the second joint. In the remaining articulations, the muscles are confined to a small part of the distal extremities, which are dilated for their reception, the muscles in each case being in pairs so that no lateral motion is obtainable.

The *mouth-organs* appeared to be very rudimentary, but were not closely examined.

The 2nd and 3rd *thoracic appendages* (gnathopoda) are short and stout and can scarcely be made out in the usual position of the animal, being carried folded closely against the ventral surface of the body. They closely resemble each other, differing only in the more anterior being stouter with its basipodite shorter than in the hinder; they are provided with a curious complex subchela (Fig. 7.). The dactylopodite forms a stout sharp claw and is articulated to the propodite by a movable joint acted on by powerful muscles. The propodite consists of a stout cylindrical curved body so bent that its posterior border is apposed to the prolonged inferior border of the carpopodite. This posterior border is armed with a strong flat plate provided with a toothed cutting edge. The carpopodite is stout, compressed, and quadrangular, and has its inforo-posterior angle prolonged into a sharp process. The posterior half of this border is formed by a thin plate with a toothed edge, opposable to the smaller plate on the propodite. In extreme flexion, these two plates overlap each other, the carpopodital plate passing inside that of the propodite; all the remaining articulations are compressed, but broad and strong, the meropodites are short and triangular, the ischiopodites short and quadrangular. The basipodite of the 2nd gnathopoda is as long as all the other articulations together, while that of the first is but $\frac{2}{3}$ as long; in both, the articulations are curved forwards and extremely stout. A cord-like glandular body runs through the middle of each of these appendages ending in the base of the propodite. It is difficult to be certain as to the point of exit of its duct, but this was doubtfully made out as opening near the angle between the two limbs of the subchela. The muscles of these appendages are large and distinct, each joint being provided with a flexor and extensor; in the two distal articulations, the flexor is by far the more powerful, but in the next the two are nearly of equal strength, while, of the muscles contained in the basipodite, the extensor is the more powerful, and its tendon, passing through the ischiopodite, is inserted into the base of the meropodite, being reinforced by only a small slip taking origin from the former joint, while only a small accessory slip of the extensor contained in the basipodite is inserted into the ischiopodite. The 4th and 5th thoracic appendages are cylindrical and of the usual ambulatory type; they are subequal, slightly exceeding the thorax in length, but the fifth is slightly the stouter of the two. The 6th and 7th are like the two preceding appendages, save that their basipodites are strengthened by strong buttress-like developments of their anterior and posterior borders; the 7th but little exceeds the 5th in length; but the 6th is the longest of all the thoracic appendages, equalling the thorax and the first abdominal segment in length. The 8th thoracic appendage is peculiar, its basipodite is formed on the same plan as those of the sixth and seventh, but is shorter, and if anything broader, so that its outline approaches the circular, and its remaining joints are so short that together they do not equal the breadth of the basipodite.

The first three *abdominal appendages* are subequal and are of quite the usual amphipod type, but are rather short. The three remaining (Fig. 8) abdominal appendages differ greatly in length; the 1st has the protopodite as long as the basipodite of the longest thoracic appendage; its two rami are foliaceous, the inner slightly exceeding the outer ramus. The 5th is but half the size of the 4th, and the irregularity of its rami is more marked, while the last appendage is but half the length of the penultimate and has its inner ramus nearly twice as long as the outer.

The animal agrees well with all the characteristics of the genus as given in Spence Bate, though the 8th thoracic appendage would perhaps be better described as stunted than as rudimentary.

§ 4. LESTRIGONUS BENGALENSIS, n. sp., Pls. VI. & VII.

In looking over the literature referring to the genera *Lestrigonus* and *Hyperia*, it becomes increasingly apparent that Spence Bate's suspicion as to the doubtful value of the latter genus was well founded. One after another species of *Lestrigonus* have been paired off as males with *Hyperia* females, so that the latter genus must, in all probability, be entirely abandoned, as its retention could only be justified by the discovery of a form whose males retain permanently the character of the genus.

The present species is one of the commonest surface organisms of the Bay of Bengal, and is especially so in the more truly pelagic portion of its area.

I was on this account able to obtain a large number of specimens,—including (*a*) females of *Hyperia* form, but with rudimentary inferior antennæ; (*b*) immature males of *Hyperia*-form; and (*c*) 9 mature males of *Lestrigonus* form,—amongst which all stages between the two latter conditions were observable.

I notice that the pelagic *Lestrigoni* are very generally credited with being parasitic on medusæ, &c. In the present species, this is not the case. I have occasionally seen them ensconced in the cavity of a Salpa, but believe this to have been an accidental circumstance, as by far the larger number were captured swimming freely.

The specimen figured (Pl. VI.) was taken in the drift-net about 100 miles from land in the Bay of Bengal, the depth of the water in the locality being 850 fathoms. Seven specimens were obtained on this occasion and some hundreds have since been taken.

As all specimens of the *Lestrigonus*-form are of nearly equal size, and all the appendages are fully developed, it is probable that they are, in spite of their small size, adult animals. The greater part of the surface of the body and appendages is liberally besprinkled with patches of black pigment, so that, seen in the water, they appeared of a dark reddish grey tint. The pigmentation is deepest on the pleura of the thoracic segments, on the basipodites of their appendages, and on the abdomen. The lower part of the cephalon, too, including the gnathites, is so deeply pigmented, that it is extremely difficult to make out the arrangement of the parts, as they are almost opaque to transmitted and nearly impossible to be illuminated by direct light. The entire length of the animal is 2·5 m.m.

The only two of the members of the genus enumerated in Spence Bate and elsewhere which approach it in size are *L. ferus* and *L. fuscus*, though both of these are considerably larger than any of my specimens. Moreover, in the present species, the seventh thoracic appendage (fourth pereiopod) is considerably larger than the preceding and succeeding appendages, whereas in *L. ferus* all three are described as subequal, and in *L. fuscus* the third pereiopod is stated to be longer than the fourth.

It differs also from the description and figures of these species in several other particulars. I would, therefore, propose to name it *L. bengalensis.*

In swimming, it progresses by a series of jerks, lying on its side and moving in small circles.

The *head* is the broadest portion of the animal, the two immense eyes projecting considerably beyond the very narrow thorax when seen from above. The eyes are of large size and distinctly faceted, the anterior faceted membrane being easily separable, and they cover the entire upper and lateral aspects of the head, the anterior aspect of which is deeply excavated for the reception of the antennæ.

The *thorax* is composed of seven distinct, but very short, segments; the junction between the pleura and the coxal plates being hard to make out, as also are the junctions of the terga of the first 5 thoracic segments. The segments increase in length slightly from before backwards, but not to any very marked extent; the entire thorax forming less than a third of the entire length of the animal.

The first three *abdominal segments* are of very large size, especially the first two, either of which is as long as any three of the thoracic segments. The fourth abdominal segment is much shorter and narrowed in front, so as to be freely movable under the much excavated posterior border of the third. The fifth and sixth abdominal segments are very small, and the latter is united without suture to the short, accurately semicircular telson.

The *antennules* are as long as the entire body of the animal *plus* the protopodite of the sixth abdominal appendage. Their peduncles consist of three joints, of which the first is large and globular and filled with a number of muscular bands, that are evidently capable of moving its articulation with the second in all directions. It contains also a small antennular gland. The second is extremely short, and the third, which is pear-shaped, is provided, along its inferior border, with a number of closely set exceedingly fine hairs. The flagellum consists of between 20 and 30 long, narrow articulations, longest in the middle of the organ, the first being exceptionally short. Each joint carries two or three exceedingly fine hairs, and the last, a pair of blunt, cylindrical hairs of uniform thickness throughout.

The *antennæ* are shorter than the antennules, equalling in length only the head, thorax, and first two abdominal segments; and, like these, their peduncles are three-jointed, the third joint being considerably longer than the two first. The flagellum is also closely similar, but differs in the first joint being long and conical, and in the armature of the terminal joint, which is provided with a pair of bifid (or, possibly, four) tapering hairs.

The dissection of the *gnathites* was attended with considerable difficulty no less on account of their extreme minuteness than because of their dense pigmentation, so that I am even now by no means satisfied as to the exact relative position of the parts in this stage of the animal. The mandibles (Fig. 6.) are stout and provided with a long three-jointed naked palp. Their masticatory plate (shown separately in Fig. 7) is peculiarly well developed, being provided with several rows of regularly arranged conical teeth. The maxillæ are liberally toothed and the maxillipedes have one of their lobes terminated by a biramous jointed appendage.

The second of the *thoracic appendages* is short and stout and provided with a somewhat incomplete subchela. The third, longer and somewhat slighter, has the subchela very well developed, the opposable prolongation of their carpopodites being distinctly hollowed out for the reception of the cylindrical propodite. The remaining thoracic appendages are of the usual type, increasing regularly in size to the seventh, which is largest; the sixth and eighth being subequal. The eighth has its posterior border provided with a strong buttress-like plate. Some of the posterior thoracic appendages are provided with gill-sacs, but I was unable to satisfy myself as to their exact number and position in this stage of the animal, although they are probably identical with those of the *Hyperia*-stage.

The first three *abdominal appendages* are subequal, and on the usual amphipod plan. The remaining three have long protopodites and small equal rami, the first two being subequal, while the last is a quarter shorter than the preceding two pairs.

The form (the *Hyperia*-stage) figured on Pl. VI. was obtained on the same occasion as the *Lestrigonus bengalensis*. The specimens were about equally divided between the sexes; and I have little doubt that the males (Fig. 1.) are merely a young stage of this species, as they agree in all essential particulars save the smaller development of the flagella of the antennæ. Even here the difference lies only in the smaller length of the individual joints and not in their number. Seen apart from the more fully developed forms, they would certainly be assigned to the genus *Hyperia*, especially some specimens, smaller than that figured, in which the antennæ are even shorter. If this supposition be correct, distinctions between *Hyperia* and *Lestrigonus* can hardly, as already advanced, be of generic value. Whether or not all male *Hyperia* ultimately develop a long flagellum is of course doubtful, but there can be little doubt that all *Lestrigonus* pass through an *Hyperia*-stage. Speaking generally, the *Hyperia*-stage is shorter and stouter and more like the female (Fig. 3.) described below. In this specimen, I could clearly make out three gill-sacs attached to the 4th, 5th, and 6th thoracic segments. I was more fortunate, too, in the dissection of the gnathites in the younger than in the adult specimen; and a glance at the incomplete figures of those of the adult form as compared with those of the more completely figured *Hyperia*-stage confirms the opinion as to the identity of the two forms. With the exception of the antennæ, the appendages are practically identical in both, save that in the younger form they are proportionally a trifle shorter than in the adult.

The female, in general form, closely resembles the young male; she is, however, shorter, but more stoutly built, the very short thoracic segments being of remarkable depth. The principal external difference between the sexes lies in the antennæ, which, in the female, are remarkably ill developed. In the *antennules*, there is a three-jointed peduncle, practically identical with that of the male, but the flagellum is reduced to a rudimentary first joint. The *antennæ* are reduced to a rudiment of the basal joint of the peduncle. All the females collected carried in a well-developed brood-pouch a number (about 18 or 20) of largish (6·25 m.) ova, none of which had gone beyond the stage of segmentation. The length of the specimen figured is 1·75 m.m.

§ 5. EURYSTHEUS HIRSUTUS, n. sp., Pl. VIII.

The species described below was taken on the same occasion as *Lestrigonus bengalensis*. It is nearly transparent and, saving a few scattered patches of reddish brown pigment, colourless. Only a single specimen was obtained.

The animal is 4 m.m. long.

The *head* is $\frac{3}{20}$ths of the total length, irregularly quadrate and smooth; it is produced anteriorly into a small blunt rostrum, and the small eye, which is pigmented red brown and consists of numerous ocelli, is placed opposite to the root of the antennules.

The *thorax* and *abdomen* are of equal length and of nearly the same depth and breadth throughout. In the thorax, the segments increase regularly in length from before backwards, while the first two of the abdomen are subequal to the hinder thoracic segments and the third is much longer than any other segment, the last three decreasing rapidly in length.

The *antennules* are rather more than half as long as the body; the peduncle forms the larger half of their length and consists of three stout joints, the distal two of which are fringed on their lower surface by a number of very long flexible hairs, the proximal joint is beset with extremely fine short hairs only, the secondary appendage is small and consists of four short joints well provided with short stiff hairs, and the flagellum consists of about eleven short articulations liberally fringed below with short fine hairs.

The *antennæ* are somewhat shorter, slightly less than half the body length; their peduncle consists of five joints, of which the first two are extremely short, the second being armed with a strong downwardly produced spine, the third joint is longer and stouter than either of those of the antennules and the fourth and fifth subequal in length and considerably longer; as in the antennules, the two distal joints are liberally fringed below with long flexible hairs; the flagellum is short, barely equalling the last joint of the peduncle in length; it consists of seven short joints all well provided with hairs, the last joint carrying, in addition, a pair of peculiar stout bifid hairs.

The *gnathites* could not be examined, with the exception of the maxillipedes, which are remarkably long and pediform.

All the *thoracic appendages* are remarkably hirsute, being covered, in addition to the large stout hairs, shown in the figure, with a perfect coat of fine hairs visible only under considerable amplification. The second and third are very weakly subchelate, the propodites being merely dilated and not produced into an opposible member. The first is much smaller and slenderer than the second, but both are on the same general plan, the dactylopodites being barely serrated and the propodites armed only with one or two stout spines. The fourth and fifth are subequal, the fourth slightly the longer and stouter; they slightly exceed the second in length and are of the usual ambulatory type. The sixth, seventh, and eighth thoracic appendages agree in having their basipodites very large and strengthened by large anterior and posterior buttress-like plates; they differ, however, considerably in length, the fifth being the shortest of all the thoracic appendages, while the sixth and seventh much exceed the anterior ones, the seventh being more than half as long as the body, and the eighth even longer.

The first three *abdominal appendages* are rather long and slender, but are quite of the usual type. The last three are short and cylindrical, having both their protopodites and rami armed with a number of short very stout spines; they decrease regularly in length from before backwards, the fourth being as long as the fifth and sixth together, and the sixth, very short. The *telson* is a short compressed lamina armed with a number of short tooth like spines similar to those on the posterior abdominal appendages.

EXPLANATION OF THE PLATES.

PLATE III.

Fig. 1. *Phronima bucephala*, n. sp., male. × 18. Fig. 2. Last three abdominal segments of the same with their appendages. × 60. Fig. 3. *Phronimella hippocephala*, n. sp. × 12·5.

PLATE IV.

Fig. 1. *Rhabdosoma investigatoris*, n. sp., female, as seen by dark ground illumination. × 3·8. Fig. 2. Thorax with appendages of the same. × 14. Fig. 3. End of an antennule. × 200.

PLATE V.

Fig. 1. *Amphipronoë longicornutus*, n. sp., male. × 17. Fig. 2. Antennule. × 39. Fig. 3. Flagellum of antennule. × 180. Fig. 4. An antenna. × 7. Fig. 5. First joint of an antenna. × 40. Fig. 6. Head seen from below (diagrammatic). Fig. 7. 2nd thoracic appendage. × 110. Fig. 8. Last three abdominal segments. × 25.

PLATE VI.

Fig. 1. *Lestrigonus bengalensis*, n. sp., male. × 40. Fig. 2. Last joint of antennule. × 400. Fig. 3. Last joint of an antenna. × 400. Fig. 4. Peduncle of antennule. × 100. Fig. 5. Peduncle of antenna. × 100. Fig. 6. Mandible and its appendage. × 200. Fig. 7. Masticatory plate of mandible. × 200. Fig. 8. The maxillæ. × 200. Fig. 9. Portion of maxilipede. × 100. Fig. 10. Last three segments of abdomen with their appendages, seen from above. × 60.

PLATE VII.

Fig. 1. *Lestrigonus bengalensis*, n. sp., immature male. × 40. Fig. 2. Last three segments, seen from below. × 40. Fig. 3. *Lestrigonus bengalensis*, female. × 40. Fig. 4. An ovum from her brood-pouch. × 40. Fig. 5. Head of female, front view. × 40. Fig. 6. Mandible and its appendages. × 200. Fig. 7. 1st maxilla. × 200. Fig. 8. 2nd maxilla. × 200. Fig. 9. Maxillipede. × 200.

PLATE VIII.

Eurystheus hirsutus, n. sp. × 40.

XVI.—*Natural History Notes from H. M.'s Indian Marine Survey Steamer* 'Investigator,' *Commander* ALFRED CARPENTER, R. N., *Commanding. No. 8. The Mean Temperature of the Deep Waters of the Bay of Bengal. By Commander* CARPENTER, R. N., D. S. O., F. R. Met. Soc., F. Z. S.—*Communicated by* THE SUPERINTENDENT OF THE INDIAN MUSEUM.

[Received August 1st;—Read August 3rd, 1887.]

(With Plate X.)

The temperature curves of the deep sea at different points in the Bay of Bengal vary but little at depths greater than 100 fathoms. The larger number of observations have naturally been made in shallow waters, that is to say, in less than 300 fathoms; but, still, more than one observation has now been obtained for every 100 fathoms down to 1900 fathoms. The greatest depth at which the temperature has been obtained is 2,105 fathoms, off the east coast of Ceylon, at which depth a Casella-Miller thermometer shewed 33°.7 Fahr. corrected for pressure, the correction being 0°·8 subtractive. As will be seen by the following example, the uniformity of temperature comes to be a check on the accuracy of the thermometers and, *vice versâ*, on the accuracy of the depth found.

Date.	No. of Thermometer used.	Depth in Fathoms.	Corrected temperature.	Locality.
8. I. 1885......	31478	675	41°·7	Near the head of the Bay of Bengal.
29. IV. 1886......	19042	675	42·1	East of Little Andaman Island.
6. V. 1886....	32096	675	41·8	Off Colombo, Ceylon.

Here we see only a variation of half a degree at the same depth in widely different places, and the error of reading off absorbs quite half of that. Unfortunately, the scale is not cut on the thermometer tube but on porcelain at the side; and, as the bent tube of the Miller-Casella admits of a small movement, care has to be taken to hold the tube firmly against the scale, so that both mercury ends shew similar readings, before taking the reading of the minimum index, which has been pushed up the tube to some lower temperature whilst under water. The uniformity of temperature also shows a uniform origin, for the change of temperature in large bodies of water is slow. The submarine inflow which must come from the southward to make up for the great evaporation of the bay, is therefore probably uniform in temperature and widely spread. It should be mentioned, however, that the observations have been entirely made in the fine season between November and May; and, although surface disturbance by wind would be unlikely to affect deep currents, yet it is just possible that the great climatic difference between the two monsoons may upset the balance in other ways and so alter the rate of submarine inflow.

Slow-moving deep currents such as would exist at the bottom of the Bay of Bengal cannot be accurately tested by any means yet devised. It is true that the United States Coast Survey have lately detailed a vessel specially to take the strength and direction of the Gulf Stream in the Straits of Florida, and that a careful section was obtained, by means of special fittings, of the strength and volume of the stream in that its narrowest portion. But even there, where considerable movement might have been expected, it never exceeded one mile an hour at the bottom, which was only some 400 fathoms deep. It is then unlikely that the same instrument, ingenious as it is, would be of any service at the greater depths owing to the far greater sources of error and the very much slower movement.

Whatever current-meter is used will have to be very sensitive, and must be anchored at the bottom for at least thirty hours, without being fouled by fish or weed, to minimise errors of lowering it down, pressure, hauling up, &c.

Surface currents are, however, guaged with comparative ease, and the depth of these as yet found by the " Investigator " range from 80 fathoms to 175 fathoms in the open waters of the bay.

Off the Rivers Hughli and Ganges, a higher temperature was frequently found at five to ten fathoms than at the surface, and this probably occurs when the fresh water of the rivers brings down a lower temperature, and temporarily overlies the salt water.

Future observations of temperature will be unlikely to vary more than one degree Fahr. from the mean curve given in the accompanying plate for depths greater than 100 fathoms; but at depths between 10 and 100 fathoms they may vary 5° either way.

A remarkable verification of depth by aid of the thermal reading was made in March last. When tabulating the mean temperatures last January, I noticed that the temperature shewn at a cast of 1400 fathoms, made in 1885, in Lat. 19°.34′ N., Long. 91°.07′ E., was far more suitable to a depth of 1000 fathoms. Upon reference to the Sounding

Record Book, it was seen that the cast was given a value of only "fair," whilst a remark was made that "the wire appeared to have lain on the bottom," too light a weight having been used to shew the instant of contact. The opportunity offered soon after of making another cast on the same spot with an improved sounding machine, when a depth of 912 fathoms was obtained with a temperature differing only one degree from that of the former cast.

Whilst taking some soundings east of the Andaman Islands in November last, I found that there were two abnormal temperatures, one of 41°.7 at 782 fathoms instead of 40°.5, which is the mean at that depth, and one of 41°.2 at 1010 fathoms instead of 37°.7. Both of these temperatures point to the water having been warmed by passage over some shallower ridge of about 740 fathoms (*see* accompanying plate).

If we look at a chart of the east side of the Bay of Bengal, we see that there are three inlets into this partly enclosed sea. One is only 150 fathoms deep, *viz.*, Preparis Channel; one is not marked with any depth, *viz.*, the Ten Degree Channel; and one has 760 fathoms marked nearly on the ridge between Acheen Head and Great Nicobar. The two high temperatures at 782 fathoms and 1010 fathoms seem to prove, so far as two observations can be a proof, that no greater depth than 740 fathoms exists on the ridges between Acheen Head and Great Nicobar and in the Ten Degree Channel.

A glance at the curve will show that a striking change occurs at 150 fathoms, and that below that depth the diminution of temperature is much more gradual.

This agrees with our observations of the depth of the surface currents, that is to say, of the quick-moving portion of this ocean. After 1200 fathoms the change of temperature becomes very slow. A line joining Sandoway in Arrakan with Calingapatam on the Orissa coast forms the southern limit of the 1200 fathom contour of the bottom of the Bay. Down to 1200 fathoms the thermometer is a check on the depth obtained, but deeper than that there is too little change.

The mean temperature of the first 150 fathoms being a moving variable* may have some influence on the climatic conditions of the Bay.

A warm surface current was met with in April in Lat. 17°.34′ N., Long. 88° E., where the water down to 120 fathoms was all 4 to 7 degrees above the mean, the greatest difference being at 60 fathoms. It was then setting to the E. N. E.

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* By 'a moving variable' I mean that that portion of the ocean which moves most rapidly has also the most varying temperature.

JOURNAL

OF THE

ASIATIC SOCIETY OF BENGAL.

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Part II.—NATURAL SCIENCE.

No. III.—1887.

XVII.—*On the* Chiroptera *of Nepal.—By* J. Scully.

[Received July 28th;—Read Aug. 3rd. 1887].

The local distribution of our Indian Mammalian fauna is not only of special interest to naturalists in this country, but is also important to those who are mainly concerned with questions of general geographical distribution. To be of real use, local lists should be founded on specimens actually captured in the region under review; less direct evidence should rarely be accepted. And nowhere, perhaps, in this great country is greater precision required in assigning a station to the forms which inhabit it than in the case of the Himalayas. For not only does the fauna of these mountains differ markedly according to the elevation above sea-level, but it also varies strikingly as we proceed from east to west in them. We have, moreover, in the Himalayas a meeting ground of Palæarctic, Indian, and Malay forms; and, for the elucidation of the complex questions of station and habitat of species, strict accuracy is required in lists of forms inhabiting merely political divisions of the Himalayas.

In view of the considerations above mentioned, the expression so often affixed to a species of "Habitat, Nepal" might be only a degree less vague than "Habitat, Himalayas," were it not for what may be called an accident. The term "Nepal" may mean either the whole State of Nepal, or a very small part of it, the Nepal Valley. The State of Nepal is about 500 miles in length, and has an average breadth of about 100 miles; part of this country differs in no way from the adjoining plains of India, but most of it is highly mountainous, and in it, indeed, is found the highest mountain in the world. The Nepal Valley, the true "Nepal" of the natives, is a small tract, some 20 miles in length by 15 in breadth, at an elevation of from 4050 to 4500 feet above sea-level, in which is situated the capital of the state, Kathmandu. But the Nepal Valley is the only part of the state which has been efficiently explored zoologically, and, consequently, we may be pretty certain that, when the term Nepal only is used to denote the station of a species, the Nepal Valley is what is really meant.

I once lived for two years in the Nepal Valley, and while there made large collections of zoological specimens. Amongst these, I preserved 40 specimens of bats, and, on my return to England, I spent some time on a careful identification of them, by reference to published descriptions and by comparison with specimens in the British Museum. In this way, I ascertained that the whole of my specimens were referable to only 10 species, and the next step was to find out whether the forms I had secured were previously known to occur in Nepal. This task proved much more difficult than the mere identification of the species; the information available about the species of Chiroptera actually inhabiting Nepal being somewhat vague and confused.

In order to show why the matter lacks precision, it is necessary to trace the source of our information on the subject.

Mr. Brian H. Hodgson, to whose labours zoological science is so largely indebted, lived for more than twenty years in the Nepal Valley; and during this time he made very extensive zoological collections, and described many new forms. He discriminated altogether *twelve* species of bats from Nepal, and to every one of these he gave a new scientific name. Unfortunately, however, he did not describe all the species whose names he published, and some of the descriptions he gave were not sufficiently full to fix the species intended without doubt. Mr. Hodgson presented most of his specimens from Nepal to the British Museum, and he also gave a few to the Asiatic Society of Bengal. This led to Dr. J. E. Gray and Mr. Ed. Blyth identifying some of Hodgson's species with others previously named by different authors, and in some cases to more extended description of the Nepalese specimens. Some doubt and error were in this way introduced, as will be explained further on; the doubt hanging over the species named by Mr. Hodgson but never described by him.

Mr. Hodgson left Nepal in 1844. He never returned to that country, but, after a visit to England, he settled for some years at Darjiling, in the Sikkim Himalayas east of Nepal, and collected zoological specimens there largely. These spoils he also gave to the British

Museum and to the museum of the East India Company in London. Mr. Hodgson's name had, however, become so firmly connected with Nepal in the minds of English zoologists, that some portion of his collections in Sikkim were wrongly assigned by them to Nepal. So that, mainly by Dr. Horsfield, Hodgson's additions of Chiroptera from Darjiling were published as coming from the former country. Owing to this confusion, at least half a dozen species of bats from Sikkim, never obtained by Hodgson in Nepal, were credited to the latter country on the strength of that naturalist having collected them.

In 1876 and 1878, Dr. Dobson's two admirable works on the Chiroptera appeared. The task this author had on hand was too extensive to permit his paying particular attention to a relatively small question like the station of certain species in Nepal; he had, moreover, to be guided to some extent by previous writers, and to rely on museum labels, which are not always accurate. He has in consequence given in his works some species as from Nepal which were not obtained there by Hodgson or any one else, and has altogether omitted mention in his synonymy of two names given by Hodgson to Nepalese species.

In short, without much balancing of evidence, it was impossible to draw up a correct list of the bats of Nepal from the writings of the authors I have referred to; and I consequently determined to investigate the whole question with the aid of the specimens I had myself collected. The result of my enquiry is set forth in this paper.

I have already mentioned Mr. Hodgson's collection of bats from Nepal. This forms the foundation of our knowledge on the subject, and the subsequent additions of material can be readily indicated. In 1871, a collector of the Indian Museum obtained 3 specimens of bats, representing two species, at Kathmandu; and the third and last collection of Nepalese Chiroptera is my own.

Mr. Hodgson named 12 species from Nepal, but some of his specimens in the British Museum show that he really obtained 13 species in that country. The collector of the Indian Museum did not, I think, add anything to Hodgson's list, although one of his specimens was described as a new species by Dr. Dobson (see p. 253). Of the 10 species which I obtained, no less than 5 were never secured by Mr. Hodgson in Nepal. The inference I draw from this is that the list of species of Chiroptera now actually known to occur in the Nepal Valley does not completely represent the forms to be found there. A considerably extended list must be the reward of future workers in that country.

As regards a list of bats inhabiting the whole State of Nepal, that would certainly include a very large number of species not to be found in the Nepal Valley; for anything I know to the contrary nearly every species of bat found in India *may* occur in Nepal territory. That must be mere matter of conjecture, for, as I have mentioned, we have only certain knowledge of the majority of forms which occur in and near the Nepal Valley.

In the following list reference is made under every species to the ample descriptions given in Dr. Dobson's works. Detailed descriptions would therefore be quite superfluous in this paper; but I have endeavoured to include such information as is available, from Indian sources, regarding the habits of the animals. It is matter for regret that our knowledge of the habits of bats is so scant.

I. Pteropus medius.

Pteropus medius, Temminck, Monogr. Mammal. i, p. 176 (1827); Dobson, Monogr. Asiat. Chiroptera, p. 18 (1876); Cat. Chir. Brit. Mus. p. 51 (1878).

Pteropus leucocephalus, Hodgson, J. A. S. B. vol. iv, p. 700 (1835).

Mr. Hodgson appears to have obtained a number of specimens of this bat in Nepal, as he presented four examples collected there to the British Museum. The type of *Pteropus leucocephalus* measured, length of head and body 10 inches, and expanse 46; the weight of the animal was 22 ounces. Dr. Dobson mentions that all these Nepalese examples have the head and under surface paler than usual, and that one specimen has an abnormal additional upper molar, immediately behind the third molar.

Mr. Hodgson informs us that this species never appears in the central region of Nepal save in autumn, when it comes in large bodies to plunder the ripe fruit in gardens. So far as the Nepal Valley is concerned, this remark hardly accords with my two years' experience of that portion of the country; for I was never able to obtain a specimen of *Pteropus medius* there. Of late years, at all events, this animal can only be regarded as a straggler to the Nepal Valley, and, whenever it does make its appearance there, I have little doubt that it merely travels about a dozen miles from the low and hot valley of the Trisul Ganga, immediately to the north-west of Nepal. Its route to a point so far in the interior of the Nepal mountains would naturally be along the easy gradient offered by the valley of the Gandak river, and its eastern-branch up to Nowakot (or Nayakot).

An interesting note will be found in Dr. J. Anderson's 'Catalogue of the Mammalia in the Indian Museum' (1881, p. 101) on some semi-migratory movements of *Pteropus medius*, in immense numbers, during autumn.

2. CYNONYCTERIS AMPLEXICAUDATA.

Pteropus amplexicaudatus, Geoffroy, Ann. du Mus. xv, p. 96 (1810).

Pteropus pyrivorus, Hodgson, Journ. Asiat. Soc. Beng. vol. iv, p. 700 (1835).

Cynonycteris amplexicaudata, Dobson, Mon. Asiat. Chir. p. 29 (1876); Cat. Chir. Brit. Mus. p. 72 (1878).

Mr. Hodgson's description of his *Pteropus pyrivorus* from Nepal leaves little doubt that he was referring to *Cynonycteris amplexicaudata*: he gives, length of head and body 6 inches, tail 0·5, expanse 24; weight 5 ounces. And Dr. Dobson's examination of the type specimen in the British Museum settles the question. Mr. Hodgson says that these bats only appear in Central Nepal in autumn, and at midnight, when they come in large bodies to plunder the fruit-gardens. As the animal was considered a perfect pest from the havoc it made among the ripe pears, he called it *pyrivorus*. He adds that when these bats appear in Central Nepal they must necessarily come from a very considerable distance, and that in the plains it is noted of them that they will travel 30 or 40 miles, and as many back, in a single night, in order to procure food.

These remarks of Mr. Hodgson as to the habits of *Pteropus pyrivorus* have been repeatedly misapplied to a totally distinct species of bat. Dr. J. E. Gray wrongly placed *Pt. pyrivorus* as a synonym of *Cynopterus marginatus* in his List of 'Mammalia in the British Museum' published in 1843. In 1844, Blyth confidently asserted that *Pteropus pyrivorus* was the same as *Cynopterus marginatus* (J. A. S. B. XIII, p. 479); it does not appear that he had seen an example named by Hodgson, but Gray certainly had two Nepalese specimens before him which are still in the collection of the British Museum. Horsfield, Hodgson himself, Hutton, and Dobson followed suit in this wrong determination. Hutton (P. Z. S. 1872, p. 693), under the head of *C. marginatus*, quotes Hodgson's account of *Pt. pyrivorus* and makes some remarks about the (supposed) wonderful feat accomplished by this bat in travelling from the plains to the Nepal Valley, and back again, in a single night. Dr. Dobson gives *Pt. pyrivorus* as a synonym, and quotes a portion of Hutton's remarks, in his article on *Cynopterus marginatus* in the Monograph of Asiatic Chiroptera (p. 26). But in the 'Catalogue of Chiroptera in the British Museum,' published two years later, he finds that *Pteropus pyrivorus* is undoubtedly *Cyn. amplexicaudata*, and gives Mr. Hodgson's remarks about its habits, correctly, under the description of the latter animal. The proverbial immortality of error, however, asserts itself, for, in the work last mentioned, we find the article on *Cynopterus marginatus* transcribed from the Monograph without excision of the references to *Pteropus pyrivorus*. The latter title is given as a synonym with a reference to P. Z. S. 1836, p. 36; and, at page 83, Capt. Hutton's misapplied remarks about *C. marginatus* being a perfect pest in Nepal &c. is repeated. It is easy to show that both these entries are erroneous. There is no mention of any bat on page 36 of the Proceedings of the Zoological Society for 1836; the page should be 46, and there will be found the name only of *Pteropus pyrivorus*, whose characters have to be sought for in the 'Journal of the Asiatic Society of Bengal,' that is to say, in Hodgson's original description in Vol. IV, 1835. Moreover, Dr. Dobson does not find any specimen of *Cynopterus marginatus* from Nepal in the British or Indian Museums, Mr. Hodgson never having obtained any example of it in that country. As to Captain Hutton's remarks on the habits of (so-called) *Cynopterus marginatus* in Nepal, that writer of course knew nothing of the bats of Nepal beyond what he derived from Hodgson's published accounts, and he merely followed Blyth and others in supposing that *Pt. pyrivorus* was a synonym of *C. marginatus.*

About the great distances supposed to be traversed by *C. amplexicaudata* in a single night in search of food, I think there is a misconception—at least so far as relates to the Nepal Valley. At the time Mr. Hodgson wrote his account of this species, he was probably not familiar with the Nowakot (or Nayakote) district, about 16 miles only in a direct line from Kathmandu. This part of the country, although situated to the north-west of the Nepal Valley, is more than 2000 feet lower than the latter; one part of it, at Devighat, being less than 2000 feet above sea-level. The climate, vegetation, and fauna of this district naturally differ strikingly from those of the Nepal Valley, and here certainly we may expect to find both *Pteropus medius* and *Cynon. amplexicaudata* quite at home. A glance at any recent large scale map of India will show the broad valley of the Gandak river stretching from the plains into the Nepal hills, and Nowakot in the valley of the Trisul Ganga, the eastern affluent of the Gandak. Although so far in the interior of the hills, it will readily be understood that, in such hot malarious valleys, we have a direct continuation of the climate and flora suited to *C. amplexicaudata.* It is no wonder then that this bat should stray from the Nowakot district into the Nepal Valley in search of food, at suitable seasons; and the supposition of its travelling 40 miles in a direct line over hill and dale, to visit the Nepal Valley at midnight, may be dismissed as improbable.

Three examples of this species, from Nepal, were presented by Mr. Hodgson to the British Museum, and these were probably the only specimens he obtained in that country.

3. CYNOPTERUS MARGINATUS.

Pteropus marginatus, Geoffroy, Ann. du Mus. xv, p. 97 (1810).

Cynopterus marginatus, Dobson, Mon. Asiat. Chir. p. 24 (1876); Cat. Chir. Brit. Mus. p. 81 (1878).

I obtained only two specimens of this species in Nepal, one from the Nowakot district about 16 miles north-west of Kathmandu; and another just within the Nepal Valley, which had evidently strayed there from the Nowakot district. The captures were effected on the 13th and 27th of July. The first example obtained is a female, evidently an old animal, as the molars are much worn, and the second is a male, apparently full grown, but not old.

The following are measurements taken from these specimens after preservation in alcohol:—

	♀	♂
Length, head and body	3·6	3·2
„ tail	0·45	0·45
„ head	1·3	1·25
„ ear (anteriorly from notch)	0·7	0·7
Breadth, ear	0·47	0·45
Length, ear to tip of nostril	1·1	1·1
eye to tip of nostril	0·5	0·47
forearm.................	2·5	2·43
thumb and claw.........	0·9	1·03
third finger.................	4·1	3·95
fifth finger...	3·1	2·9
tibia.......................	0·95	0·86
foot and claws.................	0·6	0·55
Expanse..........................	16·0	16·0

The dental formula of these two specimens is:—

Incisors $\frac{4}{4}$, canines $\frac{2}{2}$, premolars $\frac{4}{6}$, molars $\frac{4}{4}$ = 30.

Ears margined with white; wing-membrane from basal half of first toe; fur olive-brown above, pale fulvous beneath. Claws black, with white tips. Compared with specimens of *C. marginatus* in the British Museum, I could not detect any difference except in size, the Nepalese examples being decidedly small and having short ears. My measurements accord best with those of *C. brachyotus*, from S. Andaman Island, given by Dobson in the Monograph of Asiatic Chiroptera; but, as this variety does not even figure as a synonym in the Catalogue of Chiroptera published by him later, it is to be presumed that *C. marginatus* must be regarded as a species which varies greatly in all dimensions.

Mr. Hodgson did not obtain this species in Nepal, and, although it has often been quoted as from that country on his authority, it has been shown, under the head of *Cynonycteris amplexicaudata*, that this was founded on error. Consequently, the present notice is the first authentic record of the occurrence of *C. marginatus* in Nepal.

4. RHINOLOPHUS LUCTUS.

Rhinolophus luctus, Temminck, Monogr. Mammal. ii, p. 24 (1835); Hutton, Proc. Zool. Soc. Lond. 1872, p. 694; Dobson, Mon. Asiat. Chir. p. 39 (1876); Cat. Chir. Brit. Mus. p. 105 (1878).

Rhinolophus perniger, Hodgson, Journ. As. Soc. Beng. vol. xii, pt. i, p. 414 (1843.)

There seems to be no doubt now that the species described by Hodgson, from Nepal, under the name of *Rhinolophus perniger* is, as Blyth first stated, the same as *Rh. luctus*, Temminck. Mr. Hodgson gives the following measurements of the type of *Rh. perniger*, a female: length of head and body 3·25 inches, tail 1·12, head 1·31, expanse 17, ear from anteal base 1·68, ear from crown of head or posteal base 1·37, radius 2·62, third finger 4·0, tibia 1·37, foot 0·81. Captain Hutton gives, for *Rh. luctus* from Masuri, head and body 3·5 to 4·6 inches, tail 1·95 to 2·12, ear 1·5, expanse 17·12 to 18·5, radius 2·75 to 3, third finger 4·5.

Mr. Hodgson did not present any example of *Rh. perniger* to the British Museum, but he gave a skeleton of the species to the Asiatic Society in 1842, which is at present in the collection of the Indian Museum. Dr. Dobson enters this example in the catalogue appended to his 'Monograph of Asiatic Chiroptera' (p. 194), and under the heading of locality he puts "Nipal?" There can, however, be no doubt that this specimen having been received from Mr. Hodgon in 1842 must have come from Nepal and no other country. I have not been able to trace any other authentic record of a Nepalese specimen of the species.

Concerning the habits of this bat in Nepal, Mr. Hodgson says that it is shy and never approaches houses or cultivated country; and that it dwells in the deep forests and caves of the more precipitous mountains. On this Captain Hutton remarks that such are not the habits of *Rh. luctus* at higher elevations in the Himalayas further west than Nepal. I am disposed to think that Hodgson's observation is correct, so far as Nepal is concerned. I never obtained a specimen in the valley during my residence there, and, if it had anything like the habits of *Rh. minor* or of the different species of *Phyllorhina* in Nepal, I could not have failed to secure such a fine and conspicuous species as *Rh. luctus*.

As Mr. Hodgson obtained very few specimens of it in Nepal (perhaps only one), and judging from my own want of success, I believe this species to be rare in that locality. It probably affects higher elevations than the Nepal Valley. Captain Hutton has given a very interesting account of the habits of *Rh. luctus*; this has been quoted in Dr. Dobson's Monograph and, being therefore readily accessible, need not be reproduced here.

5. RHINOLOPHUS MACROTIS.

Rhinolophus macrotis, Hodgson, Blyth, Journ. As. Soc. Beng. vol. xiii, pt. i, p. 485 (1844); Hutton, Proc. Zool. Soc. Lond. 1872, p. 699; Dobson, Mon. As. Chir. p. 45 (1876), Cat. Chir. Brit. Mus. p. 110 (1878).

This species, which is only known with certainty to occur in Nepal and Masuri, was first described by Mr. Hodgson from the former locality in 1844. He presented a specimen of it to the British Museum, and another to the Asiatic Society which is now in the collection of the Indian Museum. These are the only two known examples of the species from Nepal. Mr. Hodgson mentions that *Rhinolophus macrotis* has no pubic false teats, and he gives the weight of his type specimen as one-third of an ounce.

In the following table, measurements of examples of this species from various sources are contrasted. In column I. are entered Mr. Hodgson's original measurements, II. contains those given by Mr. Blyth of a female example sent by Mr. Hodgson to the Asiatic Society, III. shows Captain Hutton's results for recent examples captured at Masuri, and IV. contains Dr. Dobson's measurements of an adult male sent by Captain Hutton from Masuri to the Asiatic Society. Dimensions in inches.

	I.	II.	III.	IV.
Head and body	1·75	1·62	2·37 to 2·5	1·7
Head.................	0·75	0·63	—	0·75
Ear from anteal base.	0·93	0·62	1·0	0·85
Interval of ears......	0·25	—	—	—
Tail.....................	0·75	0·63	0·87	0·8
Humerus...............	1·0	—	—	—
Radius..................	1·5	1·62	1·7	1·6
Third finger...........	2·3	2·25	2·37	2·2
Femur..................	0·62	—	—	—
Tibia.....................	0·62	0·63	0·7 to 0·75	0·7
Expanse...............	9·75	—	9	—
Foot.....................	—	0·37	—	0·35

It will be seen that Captain Hutton's dimensions considerably exceed those given by the other authorities. The most noteworthy divergence is in the length of the head and body, but Hutton expressly says that his measurements are taken from fresh specimens, so that part at least of the discrepancy may be accounted for by the shrinking of specimens preserved in alcohol.

Mr. Hodgson does not give any particular account of the habits of this species in Nepal. Hutton's note about the manners of these bats in Masuri is this, "They come out of the caves in the earlier twilight hours, and may be seen flitting rapidly at some height in the air, chasing the small flies and beetles which abound during the rainy season."

Dr. Dobson mentions that the type of *Rhinolophus macrotis* is in the collection of the Indian Museum. There are three specimens of this species in that collection, an adult female in alcohol presented by Mr. Hodgson in 1842, from Nepal, which has been mentioned above; and two adult males in alcohol from Masuri, presented by Captain Hutton in 1852. The Nepal specimen is therefore doubtless the type as understood by Dr. Dobson, but this fact is not mentioned in the catalogue appended to his Monograph, nor in Dr. Anderson's 'Catalogue of Mammalia in the Indian Museum' (1881).

6. RHINOLOPHUS AFFINIS.

Rhinolophus affinis, Horsfield, Zool. Research. Java, (1824); Dobson, Mon. As. Chir. p. 47 (1876); Cat. Chir. Brit. Mus. p. 112 (1878).

This species is entered here with considerable doubt. The only ground for its inclusion is an entry in the 'Catalogue of Chiroptera in the British Museum' of a specimen of *Rh. affinis* from "Nipal," presented by Mr. Hodgson. It is quite possible that the locality quoted merely rests on the evidence of an erroneous museum label, and that the specimen was really procured by Mr. Hodgson in Darjiling, where *Rh. affinis* appears to be common. No synonym is quoted under the entry of this particular specimen to show that it ever bore a name bestowed by Mr. Hodgson; and specimens of *V. mystacinus*, *Megaderma lyra*, and *Plecotus auritus*, certainly obtained by Mr. Hodgson in Darjiling or the Sikkim Tarai, and never in Nepal, are in that work entered as from Nepal.

A reference to the register of the British Museum would settle the question; for, if the specimen of *Rh. affinis* presented by Mr. Hodgson was only received in 1847, or on any subsequent date, it could not have been collected in Nepal.

However, the species is very likely to be found in Nepal, as it occurs both east and west of that country in the Himalayas, at Darjiling and Masuri.

7. RHINOLOPHUS MINOR.

Rhinolophus minor, Horsfield, Zool. Res. Java (1824); Dobson, Mon. As. Chir. p. 50 (1876), Cat. Chir. Brit. Mus. p. 114 (1878).

Rhinolophus subbadius, Hodgson, Blyth, Journ. As. Soc. Beng. vol. xiii, pt. i, p. 486 (1844).

In a catalogue of the mammals of Nepal by Mr. Hodgson, printed in Journ. As. Soc. Bengal, Vol. X. Pt. II, p. 909 (1841), a species called *Vespertilio subbadia* is mentioned. The description of this form as *Rhinolophus subbadius* only appeared three years later, as cited in the above synonymy. Dr. Dobson does not notice the title of *Rhinolophus subbadius* at all, either in his 'Monograph' or 'Catalogue of Chiroptera in the British Museum.' It will be useful to recall the descriptions and measurements given by Hodgson and by Blyth of *Rh. subbadius.* The account given by the former author is too vague to fix the species, but he fortunately sent a specimen of it to the Asiatic Society, which Blyth described in the paper in which Hodgson's diagnosis appeared.

Hodgson says that, in his species, the ears are not longer than the head, are truncated at the tip [or somewhat obtusely pointed], and ovoid. Nasal appendage quadrate, not salient, with a transverse bar nearly surmounting it towards the head. Blyth's diagnosis is, Anterior nose leaf very small, oblong, rounded above. Vertical membrane conspicuously developed, and pointed posteriorly. Behind vertical membrane a short and broad transverse membrane, divided into two lateral lobes. Hindmost angular peak with sides slightly emarginated towards the point. Nostrils not externally fringed with membrane. Over the lip is the usual horse-shoe. The following are the measurements given *(a)* by Hodgson and *(b)* by Blyth of this Nepalese species.

	(a)		*(b)*
Length, head and body......	1·5	...	1·25
,, tail....................	1·25	...	0·62
,, head......	0·62	...	0·62
,, ear....................	0·62	...	0·5
,, forearm	1·25	...	1·37
,, third finger	2·25	...	1·88
,, tibia.........	—	...	0·62
,, foot......	0·37	...	0·31
Expanse...............	7·5	...	—

No specimen of *Rh. subbadius* was presented by Hodgson to the British Museum; the example he gave to the Asiatic Society was entered in Blyth's Catalogue (p. 25) as No. 69 A. This number seems to have been accidentally removed from the specimen, and it cannot now be traced with certainty. I shall refer to this specimen later on.

I obtained an example of this species in the Nepal Valley which gave the following measurements. Length head and body 1·5 inch, tail 0·75, head 0·7, ear, 0·65, nose-leaf 0·44 × 0·28, forearm 1·4, thumb 0·23, third finger, metacarpal 1·1, first phalanx 0·43, second phalanx 0·65, fifth finger, metacarpal 1·13, first phalanx 0·36, second phalanx 0·45, tibia 0·62, foot and claws 0·3.

Ears subacutely pointed; antitragus separated by a deep angular notch. Posterior connecting process acutely pointed, considerably exceeding the vertical process of the sella in height. Terminal process of posterior nose leaf narrow and emarginate. Lower lip with three vertical grooves. Second lower premolar in the tooth row. Second upper premolar rather widely separated from the canine, and the first upper premolar standing in the tooth row. Wing membrane to tibia, 0·1 above ankle-joint.

I have no doubt that this specimen represents *Rh. subbadius* of Hodgson, and I think it is also certainly an example of the variable *Rh. minor* of Horsfield. I have compared my Nepalese specimen with examples of *Rh. minor* in the British Museum, named by Dr. Dobson. The sella is exactly the same shape, but the ears are rather larger and the horizontal nose-leaf, or horse-shoe, is slightly larger, and conceals the lip more. These slight differences are not of much importance, and I believe *Rh. subbadius*, Hodgson, may be safely considered a synonym of *Rh. minor*.

With regard to the original specimen received by the Asiatic Society from Mr. Hodgson, I have already said that it cannot be traced with certainty. In the catalogue of specimens appended to Dr. Dobson's Monograph, No. 69A of Blyth's Catalogue is not accounted for; but three specimens of *Rh. minor* are entered of which the locality, date, and donor are unknown. These bats came to the Indian Museum from the Asiatic Society, and of one of them Dr. Dobson notes that the sex is undeterminable, and that it is in a dilapidated condition. It is possible that this specimen is the type of *Rhinolophus subbadius*, received from Mr. Hodgson in 1832. In noticing these three specimens of *Rh. minor*, Dr. J. Anderson mentions that they are *types* (Cat. Mamm. Ind. Mus. 1881, p. 110).

This species does not appear to be common in the Nepal Valley; I noticed it only on a few occasions, and Mr. Hodgson does not furnish any notes about its habits. Captain Hutton records it from Masuri, but the measurements he gives of his specimens are not reconcilable with the known dimensions of *Rh. minor*. He gives the length of head and body as from 3 inches to 3·25, &c. I think the specimens whose dimensions he records could not have been *Rh. minor*.

8. RHINOLOPHUS FERRUM-EQUINUM.

Vespertilio ferrum-equinum, Schreb., Säugeth. i, p. 174 (1775).

Rhinolophus tragatus, Hodgson, Journ. As. Soc. Beng. vol. iv, p. 699, (1835).

Rhinolophus ferrum-equinum, Dobson, Mon. As. Chir. p. 53 (1876); Cat. Chir. Brit. Mus. p. 119 (1878).

This species is fairly common in Nepal. The following particulars are extracted from Mr. Hodgson's original description of his *Rh. tragatus*, obtained in the Nepal Valley :—Length of head and body 2·62 inches, tail 1·87, expanse 15·5, weight 2 ounces. The pubic false teats are strikingly developed, and have the same shape as the true pectoral teats, but even exceed them in size. The ears are "tremblingly alive all over" and capable of considerable movement and compression. "So soon as it is dark, they come forth from the cavities of rocks, in groups, to skim the surface of standing crops, or to glide around and between umbrageous trees, in search of nocturnal insects, which constitute their sole food. They make their exit rather sooner than the true bats [*Vespertilionidæ*], and always in considerable numbers. They are not migratory, nor subject to hibernation. They breed once a year, towards the close of summer, and produce two young, differing from the parents chiefly in the very restricted development of the nasal appendages."

These remarks on habits must of course be understood as applying only to Nepal and regions having a similar climate. In Gilgit, for instance, where the winter is much colder than in the Nepal Valley, *Rh. ferrum-equinum* certainly hibernates [*see* my paper on the Mammals of Gilgit, P. Z. S. 1881, p. 199].

9. PHYLLORHINA ARMIGERA.

Rhinolophus armiger, Hodgson, Journ. Asiat. Soc. Beng. vol. iv, p. 699 (1835).

Phyllorhina armiger, Dobson, Monogr. Asiat. Chir. p. 64 (1876) ; Cat. Chir. Brit. Mus. p. 135 (1878).

Mr. Hodgson was the first to name and describe this bat, from specimens obtained by him in Nepal, of which he presented three to the British Museum. This fine species is very common in the Nepal Valley at all seasons. Owing to its large size and peculiar method of hunting for its prey, its habits can be readily observed. In the following table detailed measurements of eleven examples which I preserved are set forth. It is somewhat remarkable that more than four-fifths of the total number secured should have been females.

	♂	♂	♀	♀	♀	♀	♀	♀	♀	♀	♀
Length, head and body...	4·0	4·1	3·8	4·1	3·65	3·63	3·7	3·9	3·6	4·0	4·0
tail..	—	2·25	2·35	2·1	2·2	2·4	2·4	2·3	2·4	2·4	1·9
head....	1·27	1·34	1·34	1·3	1·34	1·3	1·3	1·3	1·3	1·28	1·4
ear (anteriorly)	1·17	1·15	1·17	1·2	1·2	1·1	1·1	1·15	1·16	1·25	1·23
Breadth of ear (anteriorly)..	0·94	0·9	0·95	1·1	0·95	0·94	0·93	1·0	0.96	1·0	1·0
Length, forearm..	3·45	3·45	3·5	3·4	3·5	3·43	3·56	3·6	3·45	3·4	3·6
thumb and claw....	0·47	0·54	0·55	0·55	0·54	0·55	0·53	0·55	0·53	0·55	0·55
third finger	4·53	4·7	4·7	5·3	4·65	4·67	5·2	4·9	4·75	4·65	4·95
fifth finger...	3·68	3·7	3·65	3·75	3·8	3·73	3·8	3·85	3·7	3·65	3·85
tibia........	1·5	1·5	1·4	1·45	1·4	1·4	1·53	1·42	1·44	1·43	1·56
calcaneum	—	0·87	0·93	0·82	0·85	0·83	0·8	0·87	0 8	0·82	0·97
foot and claws....	0·65	0·7	0·7	0·72	0·65	0·73	0·74	0·73	0·67	0·65	0·7
Expanse	21·4	—	23·3	21·5	21·0	21·3	22·0	22·3	21·5	21·0	2·02

In all the specimens the glandular frontal sac is distinct, but is smaller in the females than in the males. The wing-membrane is attached to the tibia above the ankle-joint, and the distal end of the calcaneum is distinctly marked in all. Pubic warts are present in six of the females, but are absent in the three remaining examples of this sex; in one case a pubic wart measures 0·28 inch in length. Hodgson found the weight of his type specimen (a male) to be 3 ounces; in the only specimen I weighed, an adult female, I found the weight 1·5 oz. or just half the figure Mr. Hodgson gives.

This bat usually harbours during the day in caves, or commonly in lofts, out-houses, and sheds that are little used; in the latter localities it suspends itself, by the claws of the feet, from the rafters. When attaching itself in this way to the edge of a beam or rafter, the animal sways, pendulum-like, a few times until the impetus given during flight is exhausted; and it then hangs motionless with its wings folded close to the body. If slightly alarmed by the opening of a door, or any unusual noise in the room it occupies, the head is thrust out and turned carefully in various directions, as if for the purpose of finding out the cause of disturbance. On such occasions I have purposely dropped a heavy book on the floor so as to alarm the bat thoroughly. The animal would at once fly off and either take several turns round the room, or else leave it; but it invariably returned quickly and attached itself to the spot it had previously occupied.

It comes out for the capture of its prey about sunset, and its hunting grounds are gardens, orchards, cleared spaces in woods, or avenues of trees; somewhere near trees always. It is sometimes found flying on a level with the tops of the trees, but more commonly nearer the ground; a very characteristic movement it has is a slow but steady sweep round a leafy tree, or clump of trees, in search of insects which frequent the lower branches. While it was intently occupied in this circular flight I have been nearly touched on the face by this bat, as I walked across the grounds attached to my house in Nepal. And in passing so close to one it could be distinctly heard crunching the hard-bodied insects it had caught, between its strong teeth.

Sometimes these bats seem to come out of their day retreat before the insects they are in search of are to be found in plenty. On the 25th August about 6 P. M., I noticed an example of *Phyllorhina armigera* flying close to a tree. It circled twice round the tree while I was watching it, keeping about three feet above the ground. Apparently finding that none of the insects it wanted were about, it suspended itself to a small horizontal branch of the tree, just 3½ feet above the ground, and so remained for some time. It was probably waiting for a more propitious hour. Whether this was really the explanation of the pause in its flight or not, it seems certain that this bat does not ordinarily remain very long on the wing. I have often observed that in the early part of the night it alternated its pursuit of insects with short periods of repose in an out-house. On one occasion, I observed a bat of this species return three times during the evening (from about 8 to 10 P. M.) to a room I happened to be occupying; and curiously enough it always attached itself to precisely the same part of the ceiling. That part of the room, however, was the point furthest away from me, and my presence may have influenced the bat in its selection of the most quiet spot.

On another occasion, one of these bats had suspended itself to the ceiling of my study late at night, and it first attracted attention by the pattering of its droppings on the floor. On being alarmed at some noise I made in moving books, it quitted its perch and flew lumberingly round the small room. It soon ended by knocking itself violently against a wall and then fell on the floor, apparently exhausted and stunned. When I approached it, however, it flew up and once more hooked on to a beam exactly where it had been before. It does not enter lighted rooms in houses so commonly as so many other species of bats do. Indeed, on the rare occasions when I have found it in this way, its object in coming in was evidently for rest merely, either temporarily or for the night.

When captured alive (a large butterfly-net answers for this purpose), this bat has a fierce and forbidding aspect owing to its depressed muzzle and prominent canine teeth; the ears are kept in quick tremulous motion, and there is also frequent but slight movement of the facial crests. The animal is easily shot during its flight, and most of my specimens were obtained in this way.

Hodgson says that *Phyllorhina armigera* breeds once a year, towards the close of summer, and produces two young, differing from the parents chiefly in the very restricted development of the nasal appendages. I made no observations on this point, but I note that in a female specimen captured on the 27th July, the pectoral teats, which are situated near the anterior margin of the axilla, are enlarged.

10. PHYLLORHINA FULVA.

Hipposideros fulvus, Gray, Mag. Zool. and Bot. ii, p. 492 (1838).

Phyllorhina fulva, Dobson, Monogr. Asiat. Chir. p. 71 (1876); Cat. Chir. Brit. Mus. p. 149 (1878).

The following particulars are derived from three examples of this bat captured in the Nepal Valley on the 21st and 22nd August, and the 10th of January:

	♀	♀	♂
Length, head and body	2·0	2·1	1·9
„ tail............ ...	1·2	1·4	1·35
„ head.......	0·75	0·75	0·75
„ ear......	0·85	0·82	0·9
„ forearm...	1·6	1·64	1·6
„ third finger.	2·45	2·5	2·4
„ fifth finger......	2·15	2·14	2·0
„ tibia...	0·73	0·75	0·72
„ foot...............	0·33	0·34	0·3
„ calcaneum	0·35	0·4	0·37
Expanse	10·2	10·0	—

Nothing in the coloration of these specimens recalls Mr. Blyth's remark (J. A. S. B. XIII, Pt. i, p. 489, 1844) that this species is perhaps the most vividly coloured of the whole class of mammalia. The fur is long, dense, and soft, above smoky brown, the hairs white at their bases; below paler, especially on the throat. Ears and membrane dusky. Wing-membrane from the tarsus.

These examples agree well with specimens of *Phyllorhina fulva* in the British Museum, named by Dr. Dobson. That author considers that *Ph. fulva* is only a variety of *Ph. bicolor*, and on this point I cannot offer any useful opinion. But *Ph. amboinensis*, which he also regards as a variety of *Ph. bicolor*, seems to me quite distinct from *Ph. fulva*.

This species is not uncommon in the Nepal Valley, although Mr. Hodgson never obtained it. It often comes into lighted rooms at night to hunt for insects. While being pursued in a room, it constantly flies very low down, not more than a couple of feet from the floor. It is a permanent resident in Nepal and does not hibernate there.

11. PHYLLORHINA AMBOINENSIS.

Phyllorhina amboinensis, Peters, M. B. Akad. Berl. 1871, p. 323; Dobson, Mon. Asiat. Chir. p. 72 (1876); Cat. Chir. Brit. Mus. p. 150 (1878).

Phyllorhina micropus, Hutton, Proc. Zool. Soc. 1872, p. 703.

I captured two specimens of this bat in the Nepal Valley on the 22nd of October; the animals had entered a lighted room on the ground floor about 9 o'clock in the evening.

The following are dimensions of these examples—both females—in inches:—

	1	2
Length, head and body	1·6	1·7
„ tail......	1·03	1·0
„ head.............	0·65	0·65
„ ear................	0·63	0·62
Length, forearm...	1·40	1·37
„ third finger............	2·0	2·1
„ fifth finger............	1·8	1·78
„ tibia.......	0·58	0·57
„ foot.....................	0·27	0·27
„ calcaneum...	0·26	0·3
Expanse............	8·9	8·9

These specimens agree well with a bat in the collection of the British Museum, from Lingasugur in the Deccan, which had been compared with the type of *Phyllorhina amboinensis* in the Berlin Museum by Dr. Dobson. In the Nepalese specimens the wing-membrane is attached to the tarsus.

Mr. Hodgson never obtained this species in Nepal.

Captain Hutton observes that it occurs in the summer months both in the lower hills near Masuri and in the Dehra Doon. He adds that one was taken on a warm evening in September, having flown in to the lights in a room, and another was taken at the foot of the hills, in the same way, in October; but that it is by no means common.

12. VESPERUGO NOCTULA.

Vespertilio noctula, Schreb., Säugeth. i, p. 166 (1775).

Vespertilio labiata, Hodgson, Journ. Asiat. Soc. Beng. vol. iv, p. 700 (1835).

Vesperugo noctula, Dobson, Mon. Asiat. Chir. p. 88 (1876); Cat. Chir. Brit. Mus. p. 212 (1878).

Mr. Hodgson appears to have obtained only one specimen of this bat in Nepal, the type of his *Vespertilio labiata*, now in the collection of the British Museum. In his description, he says that the colour of the fur is saturate brown throughout and that of the skin, wherever uncovered by hair, purpurascent. His measurements are, length of head and body 3 inches, tail 2, and expanse 15.

I only secured a single specimen of *Vesperugo noctula* in the Nepal Valley, on the 2nd of July, in the following manner. About 8 o'clock in the evening, I heard the very shrill scream of some small animal in my bedroom, and, on going into the room, I found this bat attached to the mosquito-net covering my bed. In its flight, it had apparently alighted on the net, and there got its claws so firmly entangled that it could not escape.

The following are the measurements of this specimen:—length, head and body 3·1, tail 2·1, head 0·9, ear 0·75 × 0·6, tragus 0·3 × 0·13, forearm 2·05, thumb 0·34, third finger 3·65, fifth finger 2·2, tibia 0·75, calcaneum 0·7, foot and claws 0·45; expanse 15·0.

The colour of the fur above is rich olive-brown, beneath paler brown, and the fur on the membranes is buff. Ears and membranes dusky.

Vesperugo noctula is, I think, not common in the Nepal Valley. Mr. Hodgson says that it is found there throughout the year, does not hibernate, and quests for food solitarily.

13. VESPERUGO ABRAMUS.

Vespertilio abramus, Temminck, Monogr. Mammal. ii, p. 232 (1835).

Scotophilus fuliginosus, Gray, Cat. Hodgson's Collect. Brit. Mus. p. 4 (1845).

Vesperugo abramus, Dobson, Mon. Asiat. Chir. p. 97 (1876); Cat. Chir. Brit. Mus. p. 226 (1878).

This is a very common species in the Nepal Valley, where it is to be found at all seasons. It is very active in hunting over gardens and woods, and its flight is quick. It often enters houses at night, in pursuit of insects attracted by lights. The breeding season would appear to be in the cold weather; for none of the adult specimens captured from May to August showed any sign of rutting, but a male secured in November was evidently in rut.

The following are dimensions and some particulars of the specimens preserved:—

	♂	♂	♂	♀	♀	♂	♀
Length, head and body…. ..	1·73	1·8	1·8	1·9	1·8	1·79	1·82
„ tail….. …. .. ….	1·45	1·4	1·5	1·63	1·55	1·37	1·55
„ head…. …. ….	0·6	0·64	0·6	0·63	0·65	0·63	0·63
„ ear…… …	0·5	0·5	0·5	0·58	0·55	0·5	0·53
„ tragus.. .. …. ….	0·22	0·21	0·22	0·25	0·21	0·23	0·22
„ forearm.. .. .. ….	1·29	1·28	1·3	1·3	1·3	1·28	1·3
„ thumb.. …………	0·25	0·25	0·3	0·25	0·24	0·24	0·27
„ third finger…. ….	2·35	2·4	2·4	2·55	2·45	2·3	2·5
„ fifth finger ………	1·6	1·7	1·7	1·77	1·75	1·65	1·8
„ tibia………….. ..	0·52	0·5	0·5	0·6	0·51	0·5	0·53
„ foot and claws ……	0·26	0·26	0·27	0·3	0·26	0·27	0·25
Expanse……. …. …….	8·8	9·0	10·0	10·1	9·0	8·9	9·7

Fur above dark olive-brown, below paler and rather rufous brown; basal part of fur above and below blackish. Membranes dusky. In a male captured on the 8th November the testes appear in the form of oval bodies, 0·3 inch in length, placed on each side of the base of the tail, below, in a temporary scrotum. In this specimen, the colour of the fur differs perceptibly from that of the other examples. The fur above is a rich brown, with a wash of gold-colour in parts, due to the hairs being pale-tipped; below, the colour is sandy brown. The tips of the claws are pure white. On comparing these Nepalese examples with specimens of *V. abramus* in the British Museum, I could not detect any appreciable differences in the shape or position of the teeth, or in any other specific characters.

Mr. Hodgson presented five examples of *Vesperugo abramus*, obtained in Nepal, to the British Museum; but he does not appear to have discriminated the species, as he gave no name to it. The specimens were entered in the Catalogue of Hodgson's collection, by Dr. J. E. Gray, as *Scotophilus fuliginosus*, with *Vespertilio fuliginosus*, Hodgson, as a synonym. The latter title is really a synonym of *Miniopterus schreibersii*, as is proved by Hodgson's original description.

14. HARPYIOCEPHALUS LEUCOGASTER.

Murina leucogaster, Alph. Milne-Edwards, Nouv. Arch. Mus. vii, Bull. p. 91 (1871); Mammif. du Tibet. p. 250 (1872).

Harpiocephalus leucogaster, Dobson, Monogr. Asiat. Chir. p. 157 (1876); Cat. Chir. Brit. Mus. p. 283 (1878).

I obtained a single specimen of this bat in the Nepal Valley, on the 2nd of September. It was found dead in my room, early in the morning, and had probably killed itself by dashing against a wall.

Length, head and body 1·85 inch, tail 1.4, head 0·7, ear 0·6, tragus 0·3, forearm 1·25, thumb 0·4, third finger 2·4, fifth finger 1·85, tibia 0·65, foot and claws 0·33; expanse 9·3.

Ears oval, broadly rounded above; the inner margin convex, with a distinct spur-shaped process near its base, which projects forwards towards the posterior angle of the eye; outer margin convex.

Wing-membrane to base of distal phalanx of outer toe. Interfemoral membrane angularly emarginate at termination of calcaneum; extreme tip of tail projecting.

Fur golden-orange on head, the base of the hairs greyish; on the back pale rufous brown, grey at the base. Fur on membranes bright ferruginous, the upper surface of the interfemoral membrane and toes being well covered. Beneath, the fur is white throughout on the chin and throat, the rest of the lower parts having bicoloured fur—grey at the base with white tips.

Upper inner incisor longer than outer incisor and not touching the canine at the base; from the outer side of its base a cusp projects inwards. First upper premolar in the same plane as the canine and second premolar, about equal to the latter in vertical height and about three-fourths of its size in cross section.

Nose, lower lip, and sides of head to ears, nude and dark fleshy; membranes brownish black, but orange-coloured along forearm. Compared with a specimen of *H. leucogaster* in the British Museum, from Tibet, the ears, teeth, and thumb and claw are of the same size and shape. The only difference observable is in the colour of the fur, which is very ferruginous above in the Nepal specimen and brown in the animal from Tibet. As the two specimens must certainly be referred to the same species, it would seem that the colour of the fur is no more a reliable character in this species of *Harpyiocephalus* than in other Chiroptera (*cf.* Dobson, Cat. Chir. Brit. Mus. p. 284).

Mr. Hodgson did not obtain this species in Nepal. Of its habits in the north-west Himalayas, Captain Hutton says that it occurs at an elevation of about 5,500 feet, but does not appear to be common in the hills, the Dehra Doon being probably its true locality there. An example which flew into a room at Jeripani (below Masuri), at night, kept low down in its flight, instead of soaring towards the ceiling, passing under the tables and chairs, as if afraid to emerge into the broad glare of the lamps. "This likewise is the mode of flight when searching for insects in the open fields, where it skims closely and

somewhat leisurely over the surface of the crops and grass" (P. Z. S. 1872, p. 712).

15. VESPERTILIO NIPALENSIS.

Vespertilio pallidiventris, Hodgson, Calc. Journ. Nat. Hist. vol. iv, p. 286 (1844), (name only); Gray, Cat. Hodgson's Collect. Brit. Mus. p. 4 (1846) (not described).

Vespertilio pallidiventer, Gray, Cat. Hodgson's Collect. Brit. Mus. 2nd Ed. p. 2 (1863) (name only).

Vespertilio nipalensis, Dobson, Proc. Asiat. Soc. Beng. 1871, p. 214; Mon. Asiat. Chir. p. 141 (1876); Cat. Chir. Brit. Mus. p. 302 (1878).

The name *Vespertilio pallidiventris* first occurs in a list of the mammals of Nepal by Mr. Hodgson, published in the 'Calcutta Journal of Natural History' in 1844. Although the name given by Mr. Hodgson to this Nepalese species of bat appears in several lists subsequent to that date, he never gave any description of the animal. As he did not present any examples of it to the British Museum or the Asiatic Society, I imagine that he only obtained one specimen, which must have been lost, somehow, after it was figured. There is a well executed figure of *V. pallidiventris* in the collection of plates of Mammals of Nepal presented by Mr. Hodgson to the Zoological Society of London.

In 1871, a collector of the Indian Museum obtained a bat in Kathmandu, which Dr. Dobson described as a new species under the name of *V. nipalensis*, the type and only known specimen being an adult female example, preserved in spirit, and now in the Indian Museum, Calcutta. I have carefully examined Hodgson's original plate of *V. pallidiventris*, with Dr. Dobson's description and figure of *V. nipalensis* before me, and, so far as any conclusion can be arrived at on such data, I believe that both these names apply to the same species. The plate of *V. pallidiventris* represents a true *Vespertilio*, as evidenced by the shape of the ear and by the narrow, acutely pointed tragus; and the whole lower surface of the animal is coloured *pure white*. This white colour of the under-parts is perhaps the most marked feature in *V. nipalensis*. And, Dr. Dobson's type specimen having come from the very place where Mr. Hodgson obtained his *V. pallidiventris*, there can be no reasonable doubt about Hodgson's title having priority. But as the latter naturalist never defined his species by any description however short, or was helped to a definition by any writer before the name *V. nipalensis* was published, *V. pallidiventris* must be regarded as a synonym merely, under the accepted rules of zoological nomenclature.

Nothing is recorded about the habits of *V. nipalensis*. It appears to be restricted to Nepal, and, from what has been said above, it would seem that it is not common even in its only known habitat. A full description of the animal, with measurements of the type, is given in Dr. Dobson's works above cited.

16. VESPERTILIO FORMOSUS.

Vespertilio formosa, Hodgson, Journ. As. Soc. Beng. vol. iv, p. 700 (1835).

Vespertilio formosus, Dobson, Mon. Asiat. Chir. p. 140 (1876); Cat. Chir. Brit. Mus. p. 311 (1878).

In his original description of this species from Nepal, Mr. Hodgson gives the following measurements of the type specimen: length of head and body 2·5 inches, tail 2, expanse 12·5. He notes that the animal has a sharp visage, and that the nasal bones are slightly convexed and unite easily with a low forehead, in this respect contrasting with his *Vespertilio fuliginosa (Miniopterus schreibersii)*.

Of the habits of *V. formosus* in the Nepal Valley, Mr. Hodgson merely records that it remains there throughout the year and does not hibernate; and that it quests for food solitarily.

In the Himalayas, this bat seems to be common at Darjiling, and in Dehra Doon, and Lower Masuri; but I think it does not occur plentifully in the Nepal Valley, as only one example appears to have been obtained by Mr. Hodgson (the type, now in the British Museum), and I never secured a specimen there.

17. VESPERTILIO MYSTACINUS.

Vespertilio mystacinus, Loisler, Kuhl, Deutsch. Flederm. Ann. Wetterau. Naturk. iv, p. 55 (1819); Dobson, Monogr. Asiat. Chir. p. 133 (1816); Cat. Chir. Brit. Mus. p. 314 (1878).

This is one of the commonest bats in the Nepal Valley. It may be seen every evening throughout the year, flying rather high in the air; and it frequently enters houses at night for a short hunt near lamps or other lights. On such occasions, two individuals are often found associated. Ten examples were secured from June to November. Of these eight are adult (5 ♂, 3 ♀), and, though they were captured in the months of June, July, August, September, and October, they do not show any sign of breeding. In none of the males are the testes descended, and in the females the mammæ are not enlarged. An immature female was obtained on the 30th June, and a very young male, just able to fly, on the 3rd July. The following table shows the dimensions of the adult specimens:—

	♂	♂	♂	♂	♂	♀	♀	♀
Length, head and body ...	1·9	1·8	1·7	1·5	1·5	2·0	1·95	1·9
„ tail..................	1·4	1·55	1·6	1·5	1·55	1·5	1·45	1·8
„ head...	0·6	0·6	0·6	0·58	0·6	0·63	0·6	0·61
„ ear..	0·5	0·5	0·57	0·5	0·5	0·51	0·53	0·52
„ tragus....	0·27	0·23	0·26	0·25	0·25	0·24	0·24	0·26
„ forearm..	1·38	1·34	1·4	1·32	1·35	1·4	1·35	1·43
„ thumb...........	0·28	0·29	0·27	0·28	0·26	0·27	0·27	0·27
„ third finger.. ...	2·25	2·26	2·2	2·17	2·2	2·15	2·27	2·3
„ fifth finger......	1·74	1·7	1·7	1·73	1·7	1·75	1·75	1·8
„ foot and claws ..	0 3	0·34	0·37	0·4	0·34	0·37	0·36	0·4
„ calcaneum......	0·6	0·6	0·57	0·57	0·55	0·55	0·6	—
Expanse..................	9·5	—	9·4	9·3	9·5	9·5	9·7	10·0

Fur above dark brown; beneath ashy, the basal part of the hairs being black. Muzzle, ears, and membranes dusky, with a purplish tint. The specimen whose dimensions are entered in the third column above differs from all the others in having the forehead rather abruptly raised above the face line, the ears longer, and the third finger differently proportioned. The metacarpal bone is longer than in any of the other examples, but the first phalanx of the third finger is shorter, measuring 0·4, while in the other specimens it varies from 0·5 to 0·55. On a comparison of specimens at the British Museum,[*] I find an example of *V. mystacinus* in that collection with the third finger proportioned as in this abnormal individual; and all these Nepalese bats agree perfectly with the common *V. mystacinus* in shape of ear and tragus, and in other essential characters.

Considering how common this bat is in Nepal, it is very singular that Mr. Hodgson never seems to have obtained a specimen of it there. His first acquaintance with the species was made years after he left Nepal, when he procured it at Siligori, in the Sikkim Tarai, and named it *Vespertilio siligorensis.*

18. VESPERTILIO MURICOLA.

Vespertilio muricola, Hodgson, Journ. Asiat. Soc. Beng. vol. x, pt. ii, p. 908 (1841) (name only); Gray, Cat. Hodgson's Collect. Brit. Mus. p. 4 (1846); Dobson, Monogr. Asiat. Chir. p. 134 (1876); Cat. Chir. Brit. Mus. p. 316 (1878).

Vespertilio adversus, apud Hutton, Proc. Zool. Soc. Lond. 1872, p. 710.

This is another species from Nepal which Mr. Hodgson named but never described. He presented three examples of it, obtained in the Nepal Valley, to the British Museum, and of these Gray noted in the catalogue above quoted, "Feet large, elongate, half free; tragus elongate, lanceolate, subfalcate;" no measurements or other diagnostic particulars are given. It is difficult to see how this can be considered a definition of the species, and yet I believe it is the only description we had of Hodgon's *V. muricola* before the appearance of Dr. Dobson's 'Monograph.' That author has satisfied himself that the title *Vespertilio caliginosus* of Tomes, dating from 1859, as well as three or four other defined names published before the appearance of his monograph, really apply to the species named, but not described, by Hodgson as *V. muricola.* Under these circumstances it seems doubtful whether Hodgson's title can be retained for the species; but, as Dr. Dobson has used the name of *V. muricola* in his two important works, and changes in nomenclature are to be deprecated, I have here followed his example.

On a comparison of specimens, *V. muricola* is readily distinguished from *V. mystacinus* by the shape of the tragus. In the former, the tragus is concave on its inner margin, and is decidedly inclined inwards and rather forwards; while in *V. mystacinus* the tragus is more erect and has a straight inner margin.

Nothing is recorded about the habits of this species in Nepal, but Captain Hutton writes, "This is a common species at Mussooree and in the Dehra Doon. It is early on the wing, coming out of caves and hollow trees, flying high, and is very rapid in its movements."

19. MINIOPTERUS SCHREIBERSII.

Vespertilio schreibersii, Natterer in Kuhl, Deutsch. Flederm. Wetterau. Ann. iv p. 41 (1819).

Vespertilio fuliginosa, Hodgson, Journ. Asiat. Soc. Beng. vol. iv, pp. 700 and 701 (1835).

Miniopterus schreibersii, Dobson, Monogr. Asiat. Chir. p. 160 (1876); Cat. Chir. Brit. Mus. p. 348 (1878).

Mr. Hodgson, in describing his *Vespertilio fuliginosa,* says that in size it is somewhat smaller than *Vespertilio formosa*, and with the ears, lips, and muzzle as in the latter species. The face is sharp, but the rostrum is somewhat recurved, owing to the concave bend of the nasal bones which join a high forehead with a considerable curve. He notes that the dentition of *V. fuliginosa* is $\frac{2-2}{6}$, $\frac{1-1}{1-1}$, $\frac{5-5}{6-6}$, thus differing from *V. formosa* and *V. labiata* (= *V. noctula*), in which the molar series is $\frac{6-6}{6-6}$. The colour, he says, is wholly sooty brown.

This description is sufficient to show that Hodgson was referring to *Miniopterus schreibersii.* In Gray's 'Catalogue of Hodgson's collection in the British Museum' (1846, p. 4), six specimens of bats from Nepal are entered under the name of Sooty Scotophile (*Scotophilus fuliginosus*), with a remark that the feet are very small, in the wing to the base of the toes. This attachment of the wing-membrane would not apply to *M. schreibersii*, in which that membrane only reaches the ankle; but Dr. Gray appears to have suspected that he was including two species under one name, for he adds, "*a.—e.* Specimens in spirit. *f.* A specimen with a rather larger tragus, without any small lobe at the outer side of its base." The last-mentioned specimen was probably the type of Hodgson's *V. fuliginosa*, and I am rather surprised not to find it figuring in the list of specimens of *M. schreibersii* in the latest catalogue of bats in the British Museum. As has before been mentioned, the first five specimens called by Dr. Gray *Scotophilus fuliginosus* are really examples of *Vesperugo abramus*.

I obtained a single specimen of *M. schreibersii* in the Nepal Valley, on the 8th of February, which gave the following measurements:—

Length, head and body 2·2 inches, tail 2·2, head 0·7, ear 0·52, tragus 0·24, forearm 1·9, thumb 0·3, third finger 3·52, first phalanx of third finger 0·45, fourth finger 2·6, fifth finger 2·1, tibia 0·75, foot and claws 0·4, calcaneum 0·55; expanse 13·5.

The fur is rich dark brown above, and pale brown on the lower surface; the basal part of the fur being everywhere blackish brown. This example was secured in a curious way. I shot a crow (*Corvus splendens*) one evening in my garden, and as it fell a bat dropped from its claws, which proved to be *M. schreibersii*. The bat had evidently just been captured and killed by the crow, probably out of sheer mischief.

Mr. Hodgson says that this species remains in Nepal throughout the year and does not hibernate, and that it is solitary in habit when hunting for its prey. Captain Hutton mentions that in Masuri it is found in caves and caverns, and even in crevices of rocks, and is occasionally attracted to the lamps in a room. This no doubt means that the light of lamps attracts insects, and in pursuit of these the bat enters rooms.

It will be seen that, in the foregoing list, 19 species of bats are admitted as occurring in Nepal. One of these (*Rhinolophus affinis*) is included with doubt, the specimen of that species presented by Mr. Hodgson to the British Museum having possibly been obtained in Darjiling, and not in Nepal. Of the total 19 species, 3, namely, *Pteropus medius*, *Cynonycteris amplexicaudata*, and *Cynopterus marginatus*, are certainly not part of the fauna of the Nepal Valley. They have been found there as mere stragglers from a neighbouring tract of the country which differs essentially, in point of elevation and of fauna and flora, from our valley. These three bats extend all along the Himalayas, in the low and hot portions adjoining the plains; and they only penetrate into the hills for considerable distances, in suitable localities, up low-lying river valleys.

Of the 15 or 16 species of Chiroptera properly belonging to the Nepal Valley, only *one* (*Vespertilio nipalensis*) is, so far as known, peculiar to this small part of the Himalayas. Another species (*Rhinolophus macrotis*) is only known to occur in Nepal and at Masuri further west in the Himalayas. All the rest have a more or less wide range in the Himalayas, both east and west of Nepal.

A few words remain to be said about certain species which have been hitherto wrongly attributed to Nepal by various authors. The number amounts to six or seven, and these I will now briefly notice.

1. As already shown, *Cynopterus marginatus* has been included in the Nepal list by many writers owing to a misidentification of *Pteropus pyrivorus*, Hodgs.

2. *Megaderma lyra* is said to be represented by specimens in the British Museum from Nepal, in Dr. Dobson's 'Catalogue of Chiroptera' (p. 157). This is erroneous, as the specimens referred to were presented by Mr. Hodgson, and he first obtained the species in the Siligori Bungalow, Sikkim Tarai, in 1847, long after he had permanently left Nepal.

3. *Synotus darjilingensis* is given by Dr. Horsfield (P. Z. S. 1856, p. 395) as from Nepal, under the names of *Barbastellus communis* and *Plecotus darjilingensis*, Hodgs. This is clearly wrong, as the title given by Hodgson sufficiently shows.

4. *Plecotus auritus* is indicated by Dr. Dobson (Cat. Chir. Brit. Mus. p. 179) as from Nepal, on the evidence of the type specimen of *Plecotus homochrous*, Hodgson. That type, however, was obtained by Hodgson in Darjiling (Gray, Cat. Hodgson's Coll. 1863, p. 2), and he never got the species in Nepal.

5. Dr. Horsfield states (P. Z. S. 1856, p. 394) that *Murina suillus* (= *Harpyiocephalus harpia*) was obtained by Hodgson in Nepal. This is not so: the species was called *Noctulinia lasyura* by Hodgson, and was obtained by him in Darjiling (Gray, Cat. Hodgson's Coll. 1863, p. 3).

6. *Vespertilio mystacinus* has been stated by more than one writer to have been procured by Hodgson in Nepal. This is a mistake: he first obtained the species in the Siligori Tarai, and named it *V. siligorensis*. *Vespertilio darjilingensis* is also attributed by Horsfield (loc. cit.) to Nepal; it is probably the same as *V. mystacinus*, and if Hodgson got it in Nepal he must have named it on the model of *lucus a non lucendo*.

7: Lastly, *Nycticejus nivicolus* Hodgs. is said by Dr. Horsfield (loc. cit. p. 395) to be from Nepal. I am not certain as to what this species really is; it is possibly *Harpyiocephalus harpia*, before mentioned, but, whatever it may be, Hodgson did not get it in Nepal. The correct locality for the type is, "Sikkim Himalaya, northern region, near snow" (Gray, Cat. Hodgson's Coll. 1863, p. 3).

Considering that the list of Nepal bats is a short one, the number of errors that have collected about it is more than usually large.

XVIII.—*Notes on some recent Neolithic and Palæolithic Finds in South India.*—*By* R. Bruce Foote, F. G. S., *Superintendent of the Geological Survey of India, Fellow of the University of Madras.*—*Communicated by* the Superintendent of the Indian Museum.

[Received and Read August 3rd, 1887.]

(With a Map—Pl. XI.)

Contents.

§ 1. Introduction.

§ 2. Earliest recorded finds in South India.

§ 3. Mr. Fraser's discoveries at Bellary. Letter to the Geological Magazine, 1873. My finds in Bellary District and the South Mahratta Country, exhibited at the Vienna International Exhibition and presented to the Geological Survey Museum, 1873.

§ 4. Mr. Valentine Ball's paper "On the Forms and Geographical Distribution of Ancient Stone Implements in India," 1878.

§ 5. Finds in Salem, Tinnevelly, Madura, Trichinopoly, Nellore, and Kistna Districts, and the Nizam's Territory. Absence of littoral Kitchen-middens of the Danish type.

§ 6. Collection of Celts from North Arcot District described by Mr. John Cockburn.

§ 7. Cache of Neolithic Implements and Pottery at Pátpád, Banaganapalle State, Karnul District. Finds in the Yerra Zari Gabbi, in Billa Surgam, and other Caves, 1883—85.

§ 8. The Neolithic Settlements of the Bellary-Anantapur Country, 1884—87. Slag and Cinder-mounds and Camps. Celt-factories. Selection of granite-gneiss hills for the great majority of the settlements. Varieties of implements, &c. found. Varieties of stone selected for use. Pottery and other implements. Connection of the Neolithic and Iron Ages.

§ 9. Palæolithic remains from the shingle-fans at base of the Copper mountain, south of Bellary.

§ 1. So many communications have been made to this Society on the subject of prehistoric stone implements of various ages, discovered in different parts of India and its dependencies, that I should hesitate before making a further one, did I not believe that I have really fresh matter of great interest to lay before you, having during the last few years made various finds which determine the age of a hitherto uncertain group of remains, and throw light on the connection of the Neolithic and Iron periods. The mere discovery of important centres of manufacture of Neolithic or polished stone implements is by itself a point of great interest, and I have the pleasure of informing you of the discovery of several centres of the kind.

Most archæologists regard it as a well-established fact that our ancestors, to speak of mankind generally, passed through at least three, and in some countries four, grades of progressive civilization indicated by the character and material of their weapons and domestic implements.

In South India, up to the present day, three of these grades, or periods, are known to have been passed through by the old inhabitants; the Rude Stone Period, the Polished Stone Period, and the Iron Period. A Bronze or Copper Period has not, so far, been traced in the south, and iron had been introduced among the people living in the Southern Deccan, and was probably manufactured by them at the same time that they were still using and making implements of polished stone.

I have used the terms Palæolithic and Neolithic not only because they are extremely convenient, but because, so far as South India is concerned, they are, so far as our present knowledge goes, very fit and suitable terms. Abundant geological evidence exists in the south that a great period of time elapsed between the era of the old Stone-chippers and that of the Stone-polishers.

Whether the latter were descendants of the former is at present impossible to say, for no evidence has been yet found to prove or disprove the idea.

§ 2. The former existence of the old Stone-chippers in South India was unknown till 1863, when I had the good fortune to discover the first chipped implement in a lateritic gravel at Palaveram a few miles south of Madras. A few months later, Dr. King and I had the further good fortune to come upon another lateritic gravel some forty miles north-west of Madras, where implements, all made of quartzite, occurred *in situ* and abundantly. A fine series of these, including many of the type specimens figured in my papers in the Madras Literary Society's Journal and the volume of the Norwich Prehistoric Congress (1868), is now in the Indian Museum.

At that time, no discovery of Neolithic or polished implements had been published, nor, so far as I know, had any been made, and it fell to me to make the first discovery of such during the course of the following year, 1864. This find (a ring-stone) was noticed in my paper on the Palæolithic implements published in the Madras Journal of Literature, and is now in the Indian Museum. Not very long after, I found a good celt near the Arconum junction of the Madras Railway, which was also recorded in the same paper.

In 1865, it became known that celts of diverse shapes and sizes and in large numbers were to be seen in little shrines, or stuck up on end round the foot of sacred trees, close to many of the temples on the Shevaroy hills in Salem District. Considerable numbers of these were procured, and some found their way into the British Museum, but, so far as I know, nothing was published about them. In the same year, I found a small, but very well made, celt about eleven miles south of Nellore.

A solitary celt was reported as found on a hill near Mercara in Coorg, and the find, which was communicated to this Society in 1868 by Mr. H. A. Mangles, has repeatedly been quoted by various writers, Mr. W. T. Blanford, Mr. V. Ball, and Mr. John Cockburn amongst them, as the first made in South India, my Arconum celt being ignored, though published in 1865.

§ 3. The next Neolithic discovery in the south was made by the late Mr. William Fraser, M. I. C. E., about 1872, when he was District Engineer of Bellary. I first heard of his discovery from himself towards the end of that year. He had found numerous celts and chisels in various stages of manufacture and use, together with corn-crushers and mealing-stones, and much broken antique pottery on two hills, the North Hill at Bellary and the Peacock Hill five miles to the north-east. Mr. Fraser very kindly took me to both hills, and afforded me the pleasure of finding some specimens for myself, to which he added a few more from his own small but choice collection.

On taking leave of him, I urged him strongly to communicate his discovery to some scientific society, which he promised to do, but unfortunately never did. He died suddenly a few months later, and his collection of celts was lost, probably thrown away in ignorance of its value. It included some good celts and several remarkably good specimens of the long narrow chisel type, a form which, so far as I know, has not yet been found in other parts of India.

On my way from Bellary to Gadak, I passed a notable conical mound of slaggy cinders which stands in the middle of a small pass, the Budi Kanama, across a line of hills about sixteen miles west of Bellary, and has been described several times by various writers many years ago, among them by no less excellent an observer than the late Captain Newbold. It has been held to be of volcanic origin, and the natives regard it as the funereal mound of some great Rakshas or demon. I had only a few minutes to devote to looking over it, as I was on the march and much pressed for time. Brief as my search was, I found one celt and some mealing-stones and corn-crushers in the little rain-gullies cut in the sides of the mound, and on several lumps of slag found the impressions of stalks of coarse straw; this sufficed to disprove the volcanic cone theory, so I went on. At Hampasagra, sixty miles west of Bellary, I found a good celt lying on the top of the bank of the Tungabhadra. In the South Mahratta country, I had made a few good finds in the two previous years, the best being some seven or eight good celts of medium size on the top of a small hill fifteen miles south-west of Kaladgi. I did not publish any separate notice of these finds beyond a brief reference to them in a letter to the Geological Magazine, in which I also drew attention to Mr. Fraser's discovery. This letter appeared in April 1873. Some of those (with my Bellary specimens and a very fine collection of Palæolithic implements that I discovered in fluviatile gravels in the banks and beds of the Malprabha river and its main southern affluent, the Benihalla), I exhibited at the Vienna International Exhibition in 1873. My collection was much admired by the Austrian archæologists, and I was strongly pressed to sell it, but declined, and afterwards presented it to the Geological Survey Museum, to which it was sent from Vienna. In 1882, it was made over to the Archæological section of the Indian Museum, together with all the other collections of Palæolithic and Neolithic implements.

§ 4. Among the number of those who saw and examined my specimens in the Vienna Exhibition was Mr. Valentine Ball, then of the Geological Survey of India, a gentleman who had made various communications to this Society on the subject of stone implements in India. In 1878, Mr. Ball read a paper before the Royal Irish Academy, with elaborate tables showing the distribution, in India, Burmah, and parts of the Indian Archipelago, of stone implements of all kinds. Mr. Ball forgot my Bellary specimens, overlooked my letter to the Geological Magazine, and ignored the various references to Neolithic finds made in my various papers on Stone Implements in South India. The Shevaroy hill celts he had not heard of, and he assumed Mr. Mangles' Coorg celt to be the only Neolithic implement ever found in South India. On this very slender foundation, Mr. Ball built up a decidedly bold, if not hazardous, theory that the occurrence of polished celts only in the north-eastern quarter of India and in Burmah, of only chipped implements in the southern half of India, and of only cores and flakes in the north-western quarter of the country, was due to the different implements having been made by different races of men occupying these three distinct provinces, which met and slightly overlapped each other in Central India. Here and there, it was true, a few implements characteristic of one province occurred well within the limits of another, but such an occurrence was to be treated as what is geologically termed an "outlier", and held not to affect the general validity of the theory. Mr. Ball rejected the terms Neolithic and Palæolithic for India as conveying erroneous ideas of progression. He says in the paper referred to, "The different forms of implements seem to be rather indices of race than time." The early inhabitants of South India, according to this theory, attained only to a much lower platform of civilization than did those of North-eastern India.* While passing his paper through the press, Mr. Ball became acquainted with the collection of Shevaroy hills celts in the British Museum, which seems to have staggered him somewhat, but he still stuck to his theory and merely added a note in the press to this effect: "If the locality" (the Shevaroy hills) "is authentic, we have another instance of an outlier. Such exceptions to the main features of distribution will possibly be from time to time discovered, but they must become very numerous before they can be considered to outweigh the facts upon which the general conclusions in this paper have been founded."

Mr. Ball's paper remained unknown to me for more than six years after its publication, else I should have written at once to show how ill-founded it was, in view even of the knowledge of Neolithic remains then existing. When I did become acquainted with it, rather more than three years ago, I was making almost daily fresh discoveries of Neolithic remains in the South, and had not time to write a paper in reply, but mentioned it in a letter to Dr. John Evans, F. R. S., the greatest living authority on stone implements, and he communicated this letter and some others about my new finds to the Anthropological Society, in whose Journal for August 1886 an abstract of them was published.

§ 5. The Shevaroy Hill celts constituted the earliest Neolithic find made south of the latitude of Madras, and twelve years elapsed before any further discoveries were made in that direction. In 1878, I found the cutting half of a small celt at Uta Kovil four miles north-east from Arrizur in Trichinopoly District. Tanjore District yielded no Neolithic implements, and Madura District was also very unprolific, the only specimens found being two chert cores and a chert flake with a serrated edge formed by 7 consecutive small notches in close apposition. These were found on the surface of gravels of very recent formation.

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* The question of the distinctness of the two stone ages will be referred to again later.

Of uncertain age, but probably Neolithic, is a carved bone pendant that I obtained in 1883 out of the mud of a very interesting submerged forest at the west end of Valimukkam Bay on the south coast of the Ramnad zamindari. This is the only piece of worked bone that I know of as having been found in South India, excepting some cut bones discovered in the ossiferous caves of Billa Surgam in Karnul District. The pendant was in all probability used as an ear ornament. It is pierced at the thinner end by a small well-drilled hole, and shows four incised lines going clean round it, one a little below the perforation, the other about $\frac{1}{4}''$ above the round, thicker (lower) end. It was probably well-polished, and, though weathered, is still smooth enough to be rather glossy. I had hoped to find much of value in the Valimukkam submerged forest, my first visit of a few minutes duration having given me the bone pendant, but, on re-visiting it last year, I found that the action of a small river which opens into the bay close by, combined with a heavy surf, had covered over the greater part of the old forest area with a broad sandbank, while the surf had removed a large number of the old tree stumps which had been visible at low tide at the time of my first visit. I had a long tramp about over the peaty mud flat still remaining, but found nothing more than a piece of old pottery too much rolled to show its real character.

At my first visit to Cape Comorin in 1869, I was struck by the large consumption of shellfish made by the fisher-folk living in the coast villages, speculating that their ancestors might have had similar tastes, and I hoped that an examination of the coast would show the existence of middens, such as proved so wonderfully rich in prehistoric remains on the coasts of Jutland and Schleswig. In 1881, 1882, and 1883, I carried out the geological survey of South Travancore, Tinnevelly, and Madura, but unfortunately found no true kitchenmiddens, and fear that none will be found there, for my work, though not absolutely exhaustive, was very close in many places where such remains might have been expected. The remains of shellfish, chiefly of a large species of *Mytilus*, lie about in great quantities in many places near the coast and, here and there, at places far inland, but they do not occur in sufficiently great accumulations to deserve the name of middens, or to hide any prehistoric remains.

The Neolithic remains I obtained in Tinnevelly (in 1883) were cores and flakes of a chert foreign to that part of the country. They were found at the south end of the red sandhills forming the "teri" west of Sawyerpuram, a well-known station of the Gospel Propagation Society's Mission, eleven miles south-west of Tutikorin. The south end of the teri had been largely denuded by wind action, which had removed the fixed red sand to a depth of 15 or 16 feet, and exposed a dark red surface of hard sandy loam over an area of several acres. On this surface, I noticed some flakes of a brown chert I had seen nowhere in the South, and these flakes led me to search closer, and I soon found several well-made cores of the Jabalpur type. With the chert flakes were a few of limpid quartz, also a foreign stone in that immediate neighbourhood. A number of fragments, mostly small, of antique red pottery accompanied the chert implements and showed strong signs of having had their edges much worn by the action of "sand blast" at some previous time when the teri* was in a moving condition.

The northern part of the Carnatic had previously yielded me a few Neolithic implements, a small but perfect celt eleven miles south of Nellore (1865) and half of a large ring-stone the drilling of which had never been quite completed. This ring-stone, or perforated hammer, was found in 1875 at Vemavaram ten miles north-east of Ongoze and close to the northern boundary of Nellore district.

Some four miles to the east of the famous Amravati tope, I found (close to the village of Vayikunthipuram, on the south bank of the Kistna) what appears to be the body of a good-sized celt minus the cutting edge. This was made of a buff and purple mottled sandstone of upper Gondwana age. The only other implement made of this material was a cylindrical fragment (wanting both ends) of doubtful use, unless it may be regarded as part of a prehistoric "rolling pin." This I got on the site of a Neolithic settlement at Jerlacherru, nine miles W. of Kammamet in the Nizam's territory. The settlement had existed between two granite-gneiss hills, and the fields all round were covered thickly with fragments of high class antique pottery. I could only mourn the hard fate which denied me time to examine this very promising locality.

Another Neolithic site, on the left bank of the Umni-ern, 3 or 4 miles south of Kammamet, that I could only pass by on the march looked also very promising.

I must not forget to mention that I picked up the pointed end of a celt just south of the village of Matur, 27 miles south-east of Kammamet.

Proceeding westward, I came across a small hill of granite-gneiss south of Poolloygooda (21 miles east by south of Bonagiri), where were a considerable number of highly polished deep grooves worn into the hard rock. From their shape and size, I inferred they must have been made in grinding the cutting edges of celts, and my inference has since been confirmed by finding similar polished grooves on granitoid hills in the Bellary country which were great centres of the celt manufacture. The grooves were about 10 to 14 inches long, about 1¼ wide in the middle, and tapered off to a sharp point at either end. The greatest depth of the groove was at the centre and varied from 1½ to nearly 2 inches. The polish was best preserved in the grooves that had been filled up with soil washed in by rain.

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* Teri is the name given by the Tamil people exclusively to the great drifts of red sand which form so remarkable a feature along the eastern side of Tiinnevelly District.

A few miles west of this place, I came on a large dyke of very fine grained greenstone, the surface of the western end of which, near the village of Arur, had been considerably broken up and yet showed no signs of ordinary quarry work; a large quantity of débris of an uncommon character lay about, which struck me as having possibly been produced in the manufacture of stone implements; some of the fragments being very shapely flakes. A few minutes' search gave me a well-shaped celt in the first or rough stage. Further search would I feel sure have produced more evidence as to this having been a celt factory, but I had not the time to spare for it.

§. 7. In October 1883, I had the pleasure of making a very interesting find at Pátpád, a small village 4 miles west of Banaganpalli, in Karnul District. The spot on which the find was made is a piece of slightly irregular ground, triangular in shape, and enclosed between the high road, the end of a small limestone ridge, and a small stream which runs south-east into the Suru river, a confluent of the Peneru, or Northern Pinakini. Near the centre of the ground, I noticed a few fragments of bright red antique pottery sticking in the sides of a tiny rain-gully. Being greatly taken up with excavations in a large cave some distance off, I thought no more about them; but, a few days later, having found some interesting prehistoric pottery at some depth in excavating in one of the passages of my cave, and taken a great deal of trouble in getting all the pieces and sticking them together, my head servant, a bright and observant little Madrassee, excavated some of the broken pottery I had seen in the rain-gully just referred to and pieced it together into a very shapely bowl. After that, he dug over several square yards of the adjacent ground, under my superintendence, and we unearthed a considerable number of articles of pottery of various shapes and sizes, but all broken more or less. They were buried only 5 or 6 inches below the surface, and the place where they lay was just in the regular track of the village cattle to their drinking place and thus crossed every day several times by large herds. The wonder was everything had not been reduced to powder.

The different vessels found are mostly of admirable shape, several of them really elegant. They are of the typical glazed red and black earthen-ware so characteristic of the prehistoric graves of Coimbatoor and the Nilgiris. Two forms are, so far as I know, peculiar to that find, the one is like a flower-pot with an extremely small base, the other is conical with slightly excavated sides and no base, so that it must have been perched on a ring-stand when in use, and not held in the hand. Several such rings fitted for larger vessels were found there. In the soil which had filled some of the vessels, I found several good agate and chert cores, and a few iron implements of (with one exception) small size; long arrow-heads with strong barbs, one of which is now in the Indian Museum collection, and other forms. With these were several green-stone corn-crushers, a large stone pestle with polished sides, and a highly polished slyking-stone, or slickstone, made of a hornblendic rock. There were also a small number of point bones too much broken to identify. In addition, I found a small white bead made out of some shell, a human premolar, a shell-scraper made by grinding away the lower half of one valve of a unio shell, and, lastly, a pottery spindle-whorl. The surface of the ground a few yards to the east, which was freely scattered over with broken antique pottery, yielded a good number of agate and chert cores and flakes, all of the Jabalpur type, also a variety of larger flakes, and several small but well worked scrapers. One of these latter is an exact match to an old flint scraper from Yorkshire which I have in my collection. A large quantity of mostly bright-coloured pieces of chert, agate, jasper, quartzite, and lydian stone was also collected on the same bit of ground; having doubtless been brought there to be used in making flakes; all these stones are foreign to that immediate neighbourhood, and the agates and lydian stones must have come from a distance of 40 miles at the very least. Some of the pottery found in the Yerizari-gabbi (cave) is ornamented in precisely the same way as the large fragment of a pot (found lately at Quetta together with a very fine ringstone and a jasper corn-crusher) which Mr. Wood-Mason is exhibiting to-night.* No celts were found at Pátpád, but I got a broken cylindrical hammer on the path leading to the Yerrazari-gabbi, and, as I shall show presently, cores and flakes and the prehistoric red and black glazed pottery occur largely, together with celts and a variety of other typical Neolithic implements, in various places to the west of Pátpád; such being the case, I do not hesitate in regarding the Pátpád find as late Neolithic overlapping into the Iron Age. The whole find was presumably a cache rather than a burying place. A very fine chert flake, with an excellent core of the same material, was found at Paspalla, a village some 9 miles west of Pátpád.

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* Pottery with the same peculiar ornament has also been found on the North Hill Bellary and at Palavaram close to Madras.—Identically the same ornament appears also on pottery figured by Sir William Dawson from the old Red Indian city of Hochelagas in Canada.

§ 8. I come now to the most interesting and important part of my subject, the occurrence of numerous Neolithic settlements in the Bellary-Anantapur country, to which I proceeded at the end of 1884 to take up the geological survey of that region. Ever since my expeditions with Mr. Fraser to the North Hill and the Peacock Hill, I had been longing to revisit that quarter, and my desire had been much increased by my great find at Pátpád.

I was most anxious also to settle if possible the real nature of the great cinder-mound at Budikanava which I have already referred to above.

I revisited the North-hill at Bellary with much success and initiated a friend, Mr. Justin Boys, the Agent of the Madras Branch Bank at Bellary, into the delights of celt-hunting, which he has since followed up with a very satisfactory result, namely, the discovery that the north and east sides of the Bellary Fort Hill were also at one time inhabited by the Stone-folk.

At the first possible opportunity, I revisited the Peacock Hill, or Kapgallu as it is called by the country people. Mr. Fraser had taken me up and about the southern side of Kapgal, and we had secured but a small quantity of implements, mostly celts and chisels, but noticed no special signs of manufacture. On my second visit, I explored the whole hill, and, on the northern side, near the summit, found abundant traces of the manufacture of implements and of the residence of the manufacturers. Kapgal had evidently been a settlement of the Stone-folk for a considerable period and an important centre of celt manufacture. The traces of residence were very numerous, in the shape of small terraces revetted with rough stone walls, great accumulations of made ground full of ashes and broken pottery and containing many implements of all sorts, a large proportion of them damaged, many so much so that they had evidently been rejected as useless. Bones of bullocks, chiefly broken, occur pretty numerously and especially in the ashy parts of the made ground. Other traces of residence were small tanks made by damming up the little stream which drained the northern side of the ridge. Large blocks of the local granite-gneiss had been hollowed for some purpose or other and so well worn by use, or purposely fine-tooled, that their inner surface was all but polished. A number of these had evidently stood close to the structures that I assume to have been tanks. Some still remain there as if ready for use, but many have been broken, and their fragments lie close by. These block-troughs were not deep enough to hold any quantity of water, but may very likely have been used for mixing some kind of dough, for which they were very well adapted. A few blocks showed very shallow hollows, and such hollows are very common on rock surfaces, both in the open and under rock-shelters. Some of these I believe to have been mealing-troughs in which the grain the people used was finely mealed with mealing-stones after having been roughly bruised with smaller and lighter corn-crushers. Both of these kinds of implements are met with in great numbers here and in almost every one of the many settlements of the folk that I examined in the Bellary-Anantapur country, and are especially numerous where great accumulations of ashes and other kitchen stuff are met with.

The signs of manufacture of implements I found on Kapgal consisted of large numbers of unfinished celts in all possible states of completion and great quantities of flakes struck off from the selected fragments of rock in the process of fabrication. In the case of Kapgal settlement, the stone to be worked was procurable on the hill. It is a fine grained pale greenstone (diorite ?), which occurs here and there in irregular bands of some thickness within the mass of a huge dyke of coarse black diorite that runs along the northern slope of the hill parallel with its axis. In other settlements, the celts were found to be made from pieces of greenstone of convenient shape collected from dykes which in many cases occurred only at considerable distances ; and, in these cases, the makers often worked up pieces whose exterior was greatly pitted by weather action and did not take the trouble to remove the weathered part except where the cutting edge was made. In some few instances, pebbles were selected and so chipped as to utilize one or other of them naturally. At Kapgal, this was not the case, and consequently the celts there found have a much more recent look than those from many of the other settlements.

There is a great variety also in size and shape among the celts and chisels, especially the former. This was doubtless intentional to suit special purposes, but to some extent the makers evidently accommodated themselves to the shape of the rough stone selected for treatment. This cannot fail to strike the eye when a large series of the implements is examined. Great differences in skill, in taste, and in patience must have existed among the workers ; the beauty of shape and finish of the implements varying so very greatly. Some are really elegant in shape and others downright clumsy. The stages of manufacture through which the more or less carefully chosen rough stones passed were certainly four in number, — chipping and picking, grinding and polishing. The first stage, the chipping, was in all probability done by means of stone strikers, hammers, in fact, without handles, of which large numbers of all sizes and weights occur in all the settlements in which the manufacture was carried on. In the second stage, the surface of the chipped implement was picked or "pecked" over with a sharp-pointed striker (by which all the little ridges between the numerous chipped out surfaces were broken down and the surface rendered approximately even), and great labour saved to the grinder, who put the implement through the third stage of progress, and gave it a good sharp and even cutting edge. The fourth and final stage consisted in polishing the implement all over.

The grinding and polishing was done by rubbing the implements backwards and forwards on the surface of the granite rocks, or of big blocks, which became worn into the shallow elliptical troughs above referred to, and of which several were met with on the Kapgal hill; on some of the other settlements, these are very numerous and occur in groups where the grinders had sat together sociably over their work. On the Budihal Hill, in Anantapur District, 8 miles south-east of Bellary, are several remarkable groups of these polishing places. They are placed on high rock terraces, regular coigns of vantage commanding good views over the country where the operators could work and watch with great ease. On one rock terrace, twenty are to be seen in a space just 15 yards square. Other polishing troughs are found well under cover of great rock shelters, or in small caves, where perfect shade was obtainable during the heat of the day.

The implements lay about exposed on the surface or partly imbedded in the made ground, and some were found at a depth of 2 or 3 or more feet, where rain-gullies had cut deeply into the made ground. In every case in which I obtained numerous implements, the quantity of broken pottery was also very great, and I hardly ever got the one without the other; and now, whenever I come across fragments of antique black and red pottery, I make a special search for implements, and very rarely fail in finding something of interest.

The most numerous implements are strikers and corn-crushers, next to them numerically come the mealing-stones, then celts and chisels, the last being very rare. Less common than celts, but less rare than chisels, are worked scrapers of the Esquimaux type. Cores and core-flakes are also rare, but I imagine many more would be found, if regular excavations of the made ground of the built, or natural, terraces were carried out and the material all carefully sifted. This I had no opportunity of doing in any case, as my geological work did not admit of my devoting sufficient time for close research. In many of the settlements, numerous small stones differing in kind from the local rock were found, such as agates, chert, jasper, lydian stone, and quartz of different kinds; these had doubtless been collected to be converted into flakes and small scrapers, or, possibly, simply because of their bright and pleasing colours. In three places, stone beads of good workmanship were found; of these two were of reddish carnelian, two of delicate green quartzite of extremely fine texture, and one of shell. Lastly, I must not omit to mention several pieces of tolerably soft deep red hæmatite which had been rubbed down to smooth surfaces on one or more sides and in all probability been so rubbed down to furnish a pigment for decorative purposes, very likely as rouge for the cheeks of the Neolithic ladies. The North Hill at Bellary yielded several of these, and I noticed other pieces of hæmatite which had evidently been brought from a distance for some similar purposes, but had never been used.

Of the dwellings of the Neolithic folk, no positive traces remain; from which it may reasonably be inferred that they were of rather perishable character, like the thatched huts with mud walls of so large a proportion of the lower classes among the present inhabitants of the Southern Deccan. It is useless to speculate about what they may have been like. Small roofless huts, with rough mud and stone walls, exist in plenty at some of the many settlements, but in each case there were manifest signs of comparatively recent occupation of the place, and in no case did I find any implement or fragment of antique pottery inside such huts, although I carefully searched many of them.

Mr. Fraser discovered two settlements of the Neolithic people, those of the North Hill at Bellary and the south side of the Peacock Hill; and, since December 1884, I have found over forty others, large and small. Of these, I have prepared a list, which will be found further on. I have indicated the principal ones on the map accompanying this paper, from which will be seen how they cluster together chiefly in the neighbourhood of Bellary. Of the forty odd I have enumerated, ten, judging them by the number of implements they yielded, may be reckoned as first class, eight, as second class, and the remainder, as third class.

The respective positions of these different settlements are of importance and show that the old Stone-folk had a very decided preference for occupying commanding positions which were defensible against their enemies. These they seem to have found preferably on the granite-gneiss hills so numerously met with in the Bellary-Anantapur country. Not a single one of their settlements is found on the non-granitoid hills in the immediate neighbourhood, though many of these are as lofty, or much more so. I have given much careful consideration to this important point, and think that four good and sound reasons appear to have prevailed with the stone-folk when selecting the sites for their settlements. Doubtless, other considerations may have influenced them, but they are not so obvious. The four which seem to have mostly influenced them were :—1. The more perfect isolation of the granite-gneiss hills, which mostly rise singly out of the plains, or, if in clusters, are yet individually detached and therefore more suitable for defence than posts on continuous ridges, such as are generally formed by the schistose rocks. Some of the granite-gneiss hills are nearly perfectly castellated by the disposition of the rock masses. 2. Rock shelters of great efficiency and comfortable terraces are to be found in numbers on many of the granitoid hills, but hardly ever on the schistose hills. 3. The collection of rain water and its storage would, from the nature of the ground, be much easier on the average granitoid rock than on the average schistose hill. 4. The schistose hills are, in very many cases, generally, in fact, surrounded by a heavy and broad talus most detrimental to easy agricultural work. The granitoid hills, on the contrary, form, as a rule, no great talus, but rise up straight out of the great cotton-soil plains, so that the Neolithic field labourers could have been quite close to places of refuge in case of attack from other tribes, and yet have been able to carry on their agricultural work.

I only know one *bonâ fide* settlement situated on the schistose rocks, and this is in the open plain far away from any hill. This is near Sanawaspuram 16 miles N. by E. of Bellary.

Yet another reason in favour of the granitoid hills is that, from the many bare sheets and scarps of rock which they show, they do not bear continuous slopes of long grass capable of being burnt over, as are the uninterrupted slopes of the schist hills. The absence of these great grass spreads was a great element of safety for the thatched huts on the hills.

I referred above to the remarkable mound of slaggy cinders occurring on the Budi Kanama pass, 16 miles west of Bellary, which mound had been described by various writers 40 or 50 years ago, one of them supposing it to be a volcanic ash cone ! Captain Newbold, the most eminent amateur geologist and archæologist that South India has known, was another of these writers, and he favoured one of the native theories accounting for the origin of the mound, namely, that it was the result of a great funeral pyre on which all the dead killed in some great local battle had been cremated. Another native legend ascribes this mound to the death of Edimbassurah, a great Rakshas, or giant, killed by Bhimasainah, one of the Panch Pandus. Captain Newbold rather opposed another hypothesis that the mound might be due to the celebration of some great holocaust of animals offered on the occasion of some great religious celebration. The proper way to test the real origin of this much debated mound would of course be to cut a section through it, a work which ought to be executed by the Archæological Survey. The mound is certainly not the product of one huge burning, the cinder occurring in distinct layers 2′—4′ thick with thin layers of made ground between them. It was from these that the celts and various mealing-stones and corn-crushers I found there were washed down by action of rain. I noticed no other traces of residence, nor any at all of a manufacture of celts. I cannot help inclining to the holocaust theory, for, in other cases (notably at the important settlement on Kuri Kuppi hill and at the quadrangular cinder camp west of Sanawaspura 61 miles N. by E. of Bellary), the number of mealing-stones and corn-crushers was very large, many of them being imbedded in the cindery mass. Bones of animals, too, mostly bovine, occur frequently. Fragments of pottery too are very numerous. Many of the marrow bones had been broken as if to extract the marrow. I did not notice a single human bone in any one case, or any evidence pointing to a ceremonial cremation.

The cinder mounds at Sanawaspur, and the larger of the two west of Halakundi and near the foot of the Copper Mountain, form quadrangles about sixty yards square by external measurement, the sides making a low breastwork much trodden down and cut by rain action. I do not think they exceed 5 feet in height above the general level, for I noticed no places that I could not overlook.

Except in the absence of the signs of manufacture of implements, these two quadrangular camp-like piles of cinder showed much the same style of things as occurred on many of the larger ash-covered terraces in the typical hill settlements. Celts and chisels were probably less numerous in the camps than on the hill terraces, but mealing-stones and corn-crushers are quite as common, and broken pottery is not rare. At the Sanawaspuram camp, I obtained fragments of two small bottle-shaped earthenware vessels.

At the North Hill, Bellary, and several other settlements, I found numerous lumps of hæmatite which did not appear to have been collected for conversion into any implement, for which purpose they were evidently unfit either from their small size or softness, and with them, here and there, were pieces of iron slag, which may not improbably be traces of the local manufacture of iron. Similar indications of an iron-smelting industry were found in considerable quantity by my friend Mr. C. Cardew, Superintendent, Locomotive Department, Bellary-Kistna State Railway, in the great Neolithic settlement which formerly existed on the high ground south-west of the Guntakal Railway junction. Strongly confirmative of the existence of the iron industry at Bellary is to my apprehension the existence of a small brown earthenware tuyere which I found on the east side the Fort Hill at Bellary among a large quantity of broken pottery. This tuyere is now in my collection.

Of special interest are two implements found respectively by my friends Messrs. Boys and Cardew, the first a ring-stone found on Bellary Fort Hill, the second a wooden comb excavated from a thick bed of pure white ash in the Guntakal settlement.

The ring-stone, of which Mr. Boys found one half, was a very large one of rather oval shape externally, but the well-drilled central hole is perfectly circular.

A very fine collection of celts in various stages of manufacture and of other implements was made by another friend, Mr. Henry Gompertz, Deputy Superintendent, Madras Revenue Survey, on the north side of the Bellary Fort Hill, and on the Sangankal hills between the Bellary hills and Kapgul Hill.

Up to the present, no celt has been found in South India which has been drilled for the insertion of a handle, as were many European-made axes and hammer-heads. A very fine celt (in my collection) which was found on the Shevaroy hills shows, however, the commencement of a drill-hole on each of the broad sides. These holes are exactly opposite each other and an inch or more from the middle towards the cutting edge of the implement. The Celt-folk were, however, well acquainted with the art of drilling small objects in hard stone, as is shown by the well executed perforations of the carnelian and quartzite beads already mentioned.

A specimen (also in my collection) from one of the Bellary settlements shows the general outline of a typical celt, but the broad end has been left quite thick instead of being ground to an edge, while the pointed end has been ground to a narrow chisel edge transverse in direction to that which should have been the broad cutting edge. There are no signs of use on this specimen, which, so far as I know, is quite unique; and I am unable to imagine for what special purpose it may have been prepared.

A few specimens of whetstones, or hones, have been found in the Bellary settlements, which may perhaps have been used to give the last final edge to specially choice celts. I have two such in my collection which show strong marks of use. The marks are rather semicircular, and just such as would be produced by whetting the rather rounded edge of a celt. Mr. H. Gompertz found such a stone of rather flat shape lying on a piece of rock under a good rock shelter on the north side of Bellary Fort Hill. On the whetstone lay a small celt exactly as if it had been put down suddenly and never taken up again by the workman.

At Koganur, 7 miles E. S. E. of Davangere in Mysore, I picked up from the surface a large lump of stone (quartzite, if I recollect right) one end of which had been deeply ground into with such semicircular strokes. The stone had also been very well drilled right through the centre with a narrow hole a little more than an inch in diameter. No other traces of Neolithic remains accompanied this hammer, which, if fixed to a strong handle, must have formed a most formidable weapon, as the head weighs several pounds. By whomsoever it may have been made, the artificer had a very good knowledge of the manner in which to drill a very hard stone.

A remarkable fact with reference to the varieties of weapons and tools made by the Neolithic people of South India is the absence hitherto of any traces of their having manufactured stone arrow-heads, such as are frequently found in other countries occupied by tribes who had attained to a very similar grade of civilization. It is hard to imagine that the Neolithic people of the Deccan were unacquainted with the use of the bow prior to the first introduction of iron. That they used brass after becoming acquainted with iron is clearly proved by the discovery of unquestionable iron arrow-heads in the Pátpád cache and in many prehistoric graves in the South. With an abundance of stone, such as agate, chalcedony, lydian stone, jasper, and chert, fit for making arrow-heads, it is certainly most remarkable that no true worked arrow-heads have yet been found, and it is most desirable that all prehistoric explorers in India should pay special attention to this point. I have found some few flakes of chert and jasper that might have been used to tip an arrow, but I have found and seen none that were obviously prepared for that purpose.

I give here a list of the localities in the Bellary-Anantapur country at which the Neolithic folk have left traces of their residence and modes of life.

List of Settlements with their direct distances from Bellary Fort.

First Class.

1.	Kapgal, N. side of hill...	5	miles	N. E.	of	Bellary.
2.	Guntakal Junction	30	,,	E.	of	do.
3.	Budihal Hill..............	24½	,,	S. E.	of	do.
4.	Iddapinkal Fort Hill	19	,,	S. E.	of	do.
5.	Ditto Main Hill....	18½	,,	S. E.	of	do.
6.	Yelapadugu Hill	20½	,,	S. E.	of	do.
7.	Daroji Hill	18	,,	N.W. by W.	of	do.

8.	Kuri Kuppa Hill	18	miles	W. N. W.	of	Bellary.
9.	Gadiganur Hill, foot of	21½	„	W. N.	of	do.
10.	Latwaram Hill.............	28	„	S.E. by E.	of	do.

Second Class.

11.	Bellary North Hill	—		—	—	—
12.	Bellary Fort Hill	—		—	—	—
13.	Saudamma Konda (hill)	3½	„	N. E.	of	do.
14.	Sanarasama Konda (hill)	3¾	„	N. E.	of	do.
15.	Ram Durg Fort and Hill	24	„	E. N. E.	of	do.
16.	Karamukalu Hill	18½	„	S.E. by E.	of	do.
17.	Tornagul Hill................	16	„	W. by N.	of	do.

Third Class.

18.	Kapgal S. E. side of hill	5	miles	N. E.	of	Bellary.
19.	Halakoté N. Fort Hill ...	31½	„	N.	of	do.
20.	Ditto South Hill	31	„	„	of	do.
21.	Manakurti Hill	33	„	N. E. 3° N.	of	de.
22.	Hospett Hill (Alur Taluq)	26	„	N. E. 5° N.	of	do.
23.	Hatti Bellagul Hill	24	„	N. E.	of	do.
24.	Nagaradoni fort Hill......	25	„	E. N. E.	of	do.
25.	Chippagiri Hill............	27	„	E. by N.	of	do.
26.	Yerragudi Hill.............	42	„	E. by 5° S.	of	do.
27.	Wajra Karur (low hill) W. of......................	31½	„	E. S. E.	of	do.
28.	Hill east of great dyke east of Urava Konda	32	„	S. E. by E.	of	do.
29.	Urava Konda (hill)	26½	„	S. E. by E.	of	do.
30.	Koté Koté West Hill ...	16½	„	E. S. E.	of	do.
31.	Beder Bellagal Hill	6	„	W. by 5° S.	of	do.
32.	Kolagal East Hill.........	3½	„	N. W.	of	do.
33.	Ditto West Hill	6	„	N. W.	of	do.
34.	Hill N. of Badanhatti...	13	„	N. N. W.	of	do.
35.	Elgunda Hill................	24	„	E. S. E.	of	do.
36.	Rupangudi Fort Hill ...	13	„	S. E.	of	do.

List of Cinder Mounds and Camps.

37.	Budi Kanama or Budigunta	13½	miles	W. 5° N.	of	Bellary.
38.	Hala Kandi Camp and 1 mound	5	„	S. W. by S.	of	do.
39.	Sanawaspuram Camp...	20	„	N. 5° E.	of	do.

Smaller Cinder heaps.

40.	Rocks S. of Kapgal... ...	4½ miles	N. E.	of Bellary.
41.	Kurikuppa Hill............	18 „	W. N. W. of	do.
42.	Kakballa hill fort of	25 „	W. 5°N. of	do.
43.	Ditto do. Saddle			

Captain Newbold mentions some cinder mounds on Kapgal Hill which if still in existence escaped my attention. The great cinder mound at Nimbapuram a little to the N. E. of the ruins of Hampi (Vijayanagar), I have not yet visited. Like the Budikanama mound, it is regarded by the natives as the cremation heap of one of the great Rakshasas. It is singular that Newbold, though so keen an observer in many branches of science, should have so completely overlooked the celts and many other Neolithic implements lying so freely scattered about on Kapgal Hill and not unfrequently at Budikanama. It is more than probable, from his descriptions of the geology of the Bellary country, that he must have examined pretty closely many of the other hills in that quarter where the Neolithic settlements now referred to occur. Only one explanation seems possible to account for so able an archæologist missing these finds, namely, that, his eye being untrained and his attention not being awake to this class of prehistoric facts, he passed them by unheeded. It was not till many years after his time that the great stir in the scientific world caused by the recognition (by Lyell, Prestwich, Evans, Falconer, and the great leaders among French and German geologists) of the true value of Boucher des Perthes Palæolithic finds extended to India, and was followed by the discovery of the Palæolithic quartzite implements of Palavaram and the Attrampakkam nullah, which really started prehistoric research in this country.

The following list enumerates the varieties of implements made of stone which have been found in the Bellary-Anantapur Neolithic settlements.

1. Celts...... *a.* body narrow and round—butt end pointed.
   - *b.* do. do. and do. do. blunt.
   - *c.* do. do. and flat do. broad.
   - *d.* do. broad and round do. pointed.
   - *e.* do. do. and flat do. broad.
   - *f.* battle-axe type do. blunt.
   - *g.* cutting edge, an abrupt wedge.
   - *h.* do. a rounded wedge.
   - *i.* whole body worked square.
2. Chisels... *a.* body long and narrow.
   - *b.* do. much wider than cutting edge.
   - *c.* do. increasing backward to a thick butt; edge transverse to general plane of body.

3.	**Hammers**	*a.* round. *b.* square.
4.	Ring-stones.	
5.	Pestles.	
6.	Corn-crushers,	... globular, 1½″—2½″ diameter.
7.	Bone-crushers,	... do. 3½″—5″ do.
8.	Strikers,	... *a.* thick type.
9.	Mealing-stones,	... *b.* flat type.
10.	Slyking-stones,	... (slick-stones).
11.	Sharpening-stones,	... (hones).
12.	Scrapers,	... *a.* heavy. *b.* light. *c.* circular.
13.	Worked flakes.	
14.	Unworked flakes,	... triangular, "knife type," &c., &c.
15.	Cores, small,	... Jabalpur type.
16.	Flakes from small cores.	
17.	Beads.	
18.	Reddle-stones.	
19.	Stone vessels,	... bowl-shaped.
20.	Mealing places,	... deep, on rocks or detached blocks.
21.	Polishing places,	... do. do.
22.	Edging grooves,	... do. do.

The variety of stone selected for different purposes was considerable as will be seen by the following lists.

Varieties of stone selected for use.

Granite...	for mealing-stones and corn-crushers.	
Granite gneiss...	,, mealing-stones, mealing-troughs, polishing and edging places on the rocks, deep troughs for water.	
Epidote granite...	,, corn-crushers	these were evidently very favourite stones and often fetched from long distances.
Gneiss (green)...	,, mealing-stones	
Greenstone of several varieties.........	,, celts, scrapers, mealing-stones, corn-crushers, strikers, hammers, pestles, flakes.	
Quartz very rarely used...	,, corn-crushers and scrapers.	
Siliceous breccia of Dharwar age, very rarely used	,, mealing-stones.	

Hornblende schist (a very silky variety)...	for	celts of the flat type, very commonly at Gadiganur, elsewhere very rarely. Pestles.
Quartzite...	,,	Sharpening stones, mealing-stones, beads (very rarely).
Hæmatite, jaspery, ...	,,	mealing-stones, corn-crushers.
Jasper, red......................	,,	cores (rare).
Hæmatite, earthy red...	,,	pigment.
Agate...........	,,	cores and flakes.
Carnelian......	,,	beads.
Chert mostly of Lower Vindhyan age... ...	,,	cores, flakes, flake knives, scrapers, strikers.
Lydian stone. ...	,,	flakes and scrapers.

The bulk of the neolithic pottery is of very high class for Indian pottery, for, though it will not at all compare with Etruscan and Greek pottery, yet many specimens have been met with showing great elegance of form with very superior quality of the clay worked. As it is impossible to enlarge intelligibly on such subjects, unless they could be illustrated by well-executed illustrations, I will make my remarks on this subject very brief, reserving a full account of my pottery finds till some future time when I shall have had them built up into shape and figured. The quantity of broken pottery found lying about in the old settlements is very great, and affords in many cases abundant proof either that the population was very large, or else that the period of residence represented was of great duration. I think all the pottery collected or examined by me at the different settlements was wheel-made. In point of size and shape, the articles found can only be described as legion. The patterns of ornament employed were also extremely numerous. I have lately begun to collect fragments of sufficiently large size to show the special patterns ornamenting them, and I can only express my surprise at the great variety of patterns the old potters had invented. It is the exception rather than the rule to find the same pattern used twice over. Many of the patterns are so pretty as to cause very great regret that they are known from fragments only.

None of the vast number of specimens I have examined belonged to angular mouthed vessels; all without exception were round, but, with that limitation, they represented all possible varieties of shape, from extremely shallow plates up to rather elongated oval vessels of great size and thickness of walls, and to narrow-necked bottles.

I noticed no vessel with handles either external or internal,* but a tolerable number were found which were furnished with legs, probably three or four in number. In many settlements, I found fragments of flat saucer-like vessels perforated with many holes placed close together. These had evidently constituted strainers of some kind.

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* The internal handles for suspending vessels over a fire without risk of the flames touching the suspending ropes, such as were used by the North American

I found several small, rather rudely circular, flat discs of pottery about 2 inches in diameter, the edges of which had been coarsely ground. These were very probably lids to lay upon the mouths of vessels requiring to be closed; such discoid lids are used occasionally now-a-days for the same purpose.

The pots ornamented with a raised fillet marked with impressions greatly resembling those to be made by a human finger* found in the Yerra Zari Gaffi (Cave) struck the diggers whom I employed as very strikingly different from the pottery made locally at the present time, and they remarked upon this very intelligently. Indeed, the new and strange patterns of the old pottery called forth many more remarks than any of the other finds we made in that quarter.

In no case did I find any sign of the localities where the potters had followed their trade. These were probably well removed from the settlements (whether the latter stood on the hills or in the plains), near to the rivers, where suitable clays would be likely to be found.

§. 9. While camped at Halakundi 5 miles south of Bellary along the Bangalore road in December 1884, I obtained some 20 or 30 chipped Palæolithic implements made of jaspery hæmatite schist; they are all of rather small size but of the typical shapes, oval, pointed oval with two or three of the square-edged hatchet-shape so specially characteristic of the south of India. They were collected from the surface of a ploughed field which lies on a great fan or cone of dejection of detritus (chiefly hæmatite and hornblendic schists) formed by one of the numerous torrents coming down from the north-eastern flank of the Sugadevi belta or Copper mountain, the highest part of the band of Dharwar rocks lying south of Bellary. I am unable to offer any further evidence as to their origin at present, but they are in type utterly different from the rudest of the Neolithic implements, and they do not occur intermixed in any place that came under my notice.

Similar implements occur at distant intervals in the talus fans along the Copper mountain ridge westward. Two good specimens were

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Indians, have not yet been found by me, but they may have been used. I have one piece of thick pottery which might have served in such capacity. It would be most interesting if it were to be established that the old potters of the two continents had both hit on this most ingenious expedient.

* I am doubtful whether the impressions in question are really those of human fingers, for in none could I detect the impression of the edge of the nail.

obtained at Joga, a small village at foot of the northern ridge of the Sandur basin, 24 miles west of Bellary. The majority of the specimens have been a good deal worn by rolling. I have had no opportunity of studying the circumstances under which they occur in the gravel fans in question, and merely wish to record the finds.

The theory has been advanced that the implements of rude Palæolithic type are really the agricultural tools of the people, who, for other domestic or warlike purposes, manufactured the various wholly or partially polished implements generally classed as Neolithic. This theory will, however, not fit in with the facts observed in the Neolithic settlements above described. Nearly all the implements of Palæolithic type found in the Bellary country consist of jasperyhæmatite, only a very few of quartzite. Implements of these materials and of the older type are extremely rare in the various settlements I have searched; only two or three in all were found to the hundreds and hundreds of specimens of the newer types. It is impossible that the manufacture of hæmatitic jasper and quartzite implements should have been carried on to even a very moderate extent without leaving behind piles of splinters and flakes of the red and purple and brown stones of which they were made. These flakes and splinters would be quite as conspicuous on the granitoid hills as the green and black ones left in the preparation of the celts, chisels, and hammers made of greenstone of different kinds. The latter kind of splinters and flakes occur very largely, the former not at all. Furthermore, if the hæmatite and quartzite implements of the so-called Palæolithic type were the agricultural tools of the Neolithic people, how comes it that the former are not found largely in broken or at least used condition around the hills inhabited by their makers? It is most unlikely that the people left the rich black soil tracts around their strong places uncultivated, and yet, if these were cultivated by the particular form of tools they are assumed to have used, remains of the latter must assuredly be met with here and there near the strong places in question. As a matter of fact they have not been found in such localities, and, from their absence, only one inference seems reasonable, namely, that they were not used as supposed by the Neolithic people, but belonged to another and older race. In none of the different lateritic gravels and other deposits which have yielded typical Palæolithic implements in the South has the faintest trace of any polished implement of any kind, or of any pottery, however coarse, been found. While the deposits in which the Neolithic remains occur cannot by any possibility be treated as geological formations—they are all of them manifestly accumulations of matter entirely due to direct human agency,—and, geologically speaking, date only from yesterday.

To my mind nothing can be clearer than the existence of a great break in time between the Palæolithic and Neolithic Periods in South India. Whether this great break will ever be closed in by future archæological discoveries remains to be seen.

XIX.—*E'tude sur les Arachnides de l' Asie méridionale faisant partie des collections de l' Indian Museum (Calcutta).*—*Par* M. E. Simon, *de Paris. Communicated by* The Superintendent of the Indian Museum.

[Received September 22nd;—Read November 2nd, 1887].

II.

Arachnides recueillis aux Iles Andaman par M. R. D. Oldham.

Fam. **Attidæ.**

1.—Cytæa albolimbata, *sp. nov.*

♀. Long. 7*mm.* Cephalothorax crassus convexus postice attenuatus lævis, niger, in medio dilutior et rufescens, obscure rufulo-pubescens, vitta marginali latissima postice interrupta crasse albo-pilosa cinctus, parte cephalica in medio fulvo albidoque pilosa et parte thoracica vitta media postice abbreviata et acuta alba notatus. Oculorum pili supra fulvi infra oculos albidi. Pili clypei crassissimi albidi. Oculi antici parum disjuncti in linea parum recurva. Oculi ser. 2æ vix ante medium (inter oculos laterales anticos et medios posticos) siti. Oculorum series 3a cephalothorace haud vel vix angustior. Abdomen oblongum, supra nigrum et squamulis micantibus parce ornatum, in parte basilari sinuosa albo-marginatum et lineis mediis quatuor albidis sinuosis et fere inordinatis notatum et pone medium linea transversa alba valde dentata sectum, venter simpliciter fulvo-pubescens. Pedes, præsertim antici, breves et robusti, fulvo-ravidi, femoribus tibiisque ad basin atque ad apicem, patellis metatarsisque ad apicem nigro fulvove annulatis, partibus fulvis crasse albo-pilosis, tibiis anticis patellis non multo longioribus, aculeis validis et numerosis: patellis cunctis biaculeatis, tibiis metatarsisque anticis aculeis inferioribus et lateralibus instructis. Chelæ robustæ fusco-rufulæ, læves, albido-hirsutæ, margine inferiore sulci dentibus geminatis binis instructo. Vulvæ plaga antice fovea parva semicirculari, postice plagula rufula lævi et plana, recte transversa et utrinque rotunda notata.

Port Blair.

C. sinuatæ Dolesch. et *C. alburnæ* Keys. sat affinis, differt cephalo-

thorace crassiore pube ad maximam partem simplici, pictura cephalothoracis et abdominis, etc.

NOTA.—Le genre *Cytæa* Keyserling (in L. Koch, *Arachn. Austral.*, 1882, p. 1380) se rapproche des genres *Euryattus* Thorell, *Scæa* L. Koch,[*] *Hasarius* E. Sim. (emend. *H. adansoni*), *Ptocasius* E. Sim., *Ascyltus* Karsch, *Cocalus* C. Koch, par l'armature de la marge inférieure des chélicères, qui offre deux dents géminées ou mieux une dent très comprimée cariniforme et échancrée au sommet avec les angles formant deux pointes aigués.—Il se distingue du genre *Euryattus* Th., par l' aire oculaire parallele, nullement dilatée en arrière, des genres *Scæa* L. K., *Hasarius* et *Ptocasius* E. S., par sa pubescence squameuse et la marge superieure des chélicères pourvue de 2 ou 4 dents, tandis qu'elle n' en offre que deux chez les genres cités.—Il diffère du genre *Ascyltus* Karsch, par le céphalothorax non dilaté *ni conique aux angles* antérieurs et les tibias antérieurs pourvus d' épines dorsales et latérales externes. Enfin, il se distingue du genre *Cocalus* C. Koch[†] par les yeux antérieurs en ligne recourbée, les yeux de la 3^{e} ligne évidemment plus petits que les latéraux de la première, les chélicères médiocres et verticales dans les deux sexes.

Indépendamment des espèces decrites par Keyserling dans l' ouvrage de L. Koch, le genre *Cytæa* renferme encore le *S. sinuatus* Doleschall, classi par Thorell dans le genre *Plexippus*, le *Plexippus laticeps* Thorell, et peut-être aussi les *P. expectans*, *ruber* (Walck.), *argentosus*, *severus*, *nimbatus*, *frontaliger*, *ochropis*, *pupulus* Thorell (Rag. Mal. etc. 111) de Nouvelle Guinée, l' auteur ne décrit malheureusement pas pour toutes ces espèces l' armature des chélicères.

2.—CYLLOBELUS[‡] MINIACEOMICANS, *sp. nov.*

♀. Long 5·6*mm.* Cephalothorax niger pube subsquamosa pallide

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[*] *Scæa* L. Koch 1879, nom préoccupé que nous proposons de remplacer par celui de *Servæa*.

[†] Le type du genre *Cocalus* est le *C. concolor* C. Koch, de Malaisie, qui nous paraît être la même espèce que le *Salticus* (*Attus*) *forceps* Doleschall ; cet auteur a bien figuré la bifurcation de la dent principale des chélicères. Le *Plexippus erythrocephalus* C. Koch, de Java, appartient probablement au même genre, le *Cocalus cyaneus* C. Koch, de Surinam, pour lequel C. Koch a plutard proposé le genre *Psecas* s' en éloigne au contraire beaucoup et paraît plus voisin des *Mævia*.—Plusieurs des espèces décrites par Thorell sous le nom generique de *Cocalus* sont très douteuses pour le genre (*C. salax*), par contre plusieurs de ses *Plexippus* pourraient lui appartenir (*P. aper*, *catellus*).

[‡] Pour le genre *Cyllobelus*, cf. E. Sim., *Ann. Soc. ent. Fr.* 1885, p. 390. Le *Salticus collingwoodi* Cambr. (Proc. Zool. Soc. Lond. 1871, p. 621, pl. xliv f. 5) de Labuan, appartient peut-être à ce genre ; il se rapproche de *C. miniaceomicans* par son système de coloration.

cinereo-viridi nitida obtectus, parte cephalica inter oculos posticos vitta transversa lata leviter arcuata, parte thoracica maculis binis latis obliquis et vitta submarginali lata postice interrupta læte miniaceo-pilosis ornatis. Oculorum pili faciei supra aurantii infra oculos albidi. Clypeus subglaber paululum retro obliquus et in medio depressus, oculis anticis tantum $\frac{1}{3}$ angustior. Oculi antici contigui, in linea recta. Oculi ser. 2æ fere in medio inter laterales anticos et posticos siti. Oculorum series postica cephalothorace haud augustior. Abdomen ovatum, postice acuminatum, splendide viridi-metallico squamulatum, antice maculis binis magnis, pone medium vitta transversa latissima medio triangulariter dilatata miniaceo-pubescentibus et vittis transversis angustioribus pallido cinereo-viridibus decoratum. Venter antice et in medio subglaber utrinque et præsertim postice squamulis splendide violaceo-micantibus ornatus. Sternum nigrum albo-squamulatum. Pedes longi fulvi, valde nigro-lineati, femoribus anticis fere omnino nigris. Pedes-maxillares luridi, femore infuscato.

Port Blair.

Fam. **Lycosidæ.**

3.—Sphedanus[*] marginatus, *sp. nov.*

♀. Long. 19·5*mm.* Cephalothorax oblongus fusco-rufescens, pilis plumosis fulvis albisque mixtis vestitus, vitta submarginali latissima valde flexuoso-dentata atque in parte cephalica lineis trinis (media recta lateralibus arcuatis) albo-pilosis ornatus. Oculi medii subæquales, aream evidenter longiorem quam latiorem et antice quam postice angustiorem occupantes. Oculi quatuor antici appropinquati subæquales lineam leviter recurvam formantes. Clypeus oculis anticis non multo latior. Abdomen longe oblongum fuscum, supra pilis plumosis fulvo-nitidis subtus pilis simplicibus albidis dense vestitum. Chelæ fulvo-rufescentes albido-setosæ, margine inferiore sulci dentibus æquis trinis, superiore dentibus trinis medio majore instructis. Sternum olivaceum albo-pilosum. Pedes lutei, aculeis nigris longis et numerosis ut in *S. undato* Th. valde instructi (vulva haud plane adulta).

Port Blair.

A *S. undato* Thorell praesertim differt cephalothorace longiore et albo-variegato, area oculorum mediorum evidentius longiore, etc.

Fam. **Epeiridæ.**

4.—Gasteracantha annamita, E. Sim., *Act. Soc. Linn. Bord.* 1886. Commun aux Iles Andaman : Port Blair, Havelock.

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[*] Sur le genre *Sphedanus*, cf. Thorell, *Studi s. Ragni Malesi et Papuani*, I, p. 182, Gênes, 1877.

NOTA.—*Stanneoclavis canningensis* Stol., qui m' a été communiqué en même temps que le précedent par l' *Indian Museum*, paraît très commun à Barren Island (Baie de Bengale). Contrairement aux conclusions que nous avons donnée précedemment, cette espèce pourraît n' être qu' une variété de *S. brevispina* Doleschall. Les caractères que nous avons indiqués pour séparer les deux formes s' effacent considérablement chez les exemplaires du Barren Island.

5.—CYCLOSA ALBISTERNIS, *sp. nov.*

♀. Long. 7·5*mm.* Cephalothorax pallide luridus, longe albo-pilosus, anguste nigro-marginatus, parte cephalica postice maculis geminatis binis divaricatis albo-opacis notata, ovato-elongatus, parte cephalica parum convexa haud constricta. Area oculorum mediorum longior quam latior, oculi postici majores juxte contigui, antici anguste separati. Oculi laterales a mediis sat late remoti utrinque contigui et subæquales. Clypeus oculis mediis anticis haud latior. Abdomen altissimum, oblongum, antice valde prominens, simpliciter et obtuse acuminatum, prope medium obtusissime vix distincte bituberculatum, postice attenuatum et sat longe productum, apice obtuse trifidum, mucrone medio reliquis longiore et graciliore, testaceum pallide flavo-aureo-guttulatum, utrinque leviter nigro-variagatum et striolatum. Mammillæ nigræ. Sternum albo-opacum. Oris partes pallide testaceæ. Chelæ fulvæ. Pedes breves, luridi, femoribus annulo submedio angusto et macula superiore subapicali, tibiis metatarsisque annulo apicali angusto nigricantibus notati, tibiis aculeis brevibus paucis munitis, metatarsis muticis. Vulvæ uncus rufulus acute triquetrus, supra ad apicem sulcatus, scapum fuscum transversum utrinque rotundum, in medio depressum et plagula media rufula cordiformi notatum.

♂. Long. 4·6*mm.* Cephalothorax paulo latior et humilior, fuscus, parte thoracica in medio late dilutiore et rufula, subtiliter coriaceus, parte thoracica in medio depressa et sulco longitudinali abbreviato secta. Abdomen minus et præsertim angustius, postice breviter productum et simpliciter obtusum, fusco-olivaceum, in parte fasali lineis longitudinalibus albis quatuor, medianis rectis postice divaricatis, lateralibus arcuatis, in parte apicali punctis albidis biseriatim ordinatis ornatum. Venter nigricans. Sternum fusco-rufulum, maculis marginalibus dilutioribus ornatum. Pedes, præsertim antici, longiores, coxis anticis fuscis, patellis fuscis, reliquis articulis luridis, annulo medio angusto et annulo apicali lato fuscis ornatis, tibiis metatarsisque anticis parce aculeatis. Tibia paris 2æ tibia paris 1æ leviter robustior et levissime arcuata, intus aculeis robustioribus et brevibus biseriatis 6—4 armata (serie inferiore dimidium apicalem articuli tantum occupante). Pedes-maxillares breves et robusti fusco-rufuli, bulbo maximo, transversim late ovato, apice apophysibus tribus munito, apophysi superiore depressiuscula late rotunda, media gracili sed obtusa, inferiore styliformi longe bifida.

Var. ♀. Abdomen supra vitta longitudinali rosea anguste argenteo fuscoque marginata læte decoratum.

Port Blair. Havelock.

O. anseripedi Walck. affinis, imprimis differt in femina cephalothorace lurido sterno albo, oculis lateralibus a mediis remotioribus, pedibus anticis brevioribus angustius annulatis, vulvæ unco acutiore et rufulo, etc.

NOTA.—nous possedons aussi cette espèce de Ramnad (Hindoustan méridional).

6.—TETRAGNATHA GRACILIS Stoliczka, *Journ. Asiat. Soc. Beng.* XXXIII. Pt. II, 1869, p. 244, pl. XIX, f. 2 (sub *meta*).

Saddle Hill (North Andaman Island); Havelock.

Paraît commun. Décrit par Stoliczka des environs de Calcutta sous le nom générique de *Meta*.

Fam. **Avicularidæ.**

Genus SATZICUS *nov.*

Cephalothorax humilis subplanus haud vel vix longior quam latior sed antice valde attenuatus et fronte angusta, fovea thoracica pone medium sita valde recurva. Area oculorum a margine antico parum remota, saltem $\frac{1}{3}$ latior quam longior. Oculi quatuor antici in linea validissime procurva semicirculari, medii lateralibus saltem duplo majores et a lateralibus quam inter se remotiores. Oculi postici minutissimi utrinque contigui atque a mediis anticis parum distantes. Spatium inter oculos laterales anticos et posticos latissimum. Chelæ parvæ, subverticales, muticæ. Pars labialis coxæque omnino muticæ. Pars labialis paulo latior quam longior. Sternum sat latum sed antice valde attenuatum. Pedes (♂) sat longi 4, 1, 2, 3, aculeis paucis gracilibus muniti, tarsis metatarsisque anticis longe sed parum dense scopulatis, posticis setosis sed tarsis cunctis fasciculis unguicularibus validis munitis. Ungues bini graciles et (saltem posteriores) mutici. Patellæ anticæ tibiis non multo breviores. Trochanter paris 4æ longus et teres, coxa non multo brevior.

Generi *Sarpedoni* Cambr. (gen. mihi ignoto) sat affinis, differt imprimis oculis mediis anticis lateralibus saltem duplo majoribus (in *Sarpedone* paulo minoribus) et fovea thoracica valde recurva (in *Sarpedone* recto transversa).

NOTA.—Le genre *Sarpedon* Cambr. (Proc. Zool. Soc. Lond., 1883, p. 353), qui nous est inconnu en nature, a été comparé par l' auteur au

genre *Moggridgea*, dont il paraît cependent diffèrer grandement, ce dernier appartenant à la série des *Avicularidæ trionichi.*

Il est selon nous beaucoup plus voisin du genre *Leptopelma* Ausserer; l' auteur ne parle pas des chélicères, qui d'après la figure (loc. cit., pl. xxxvi, f. 1) paraissent mutiques.

7.—SATZICUS ANDAMANICUS, *sp. nov.*

♂. Ceph.-th. long. 5 *mm.*; lat. 4·8 *mm.* Pedes I 15·7 *mm.*; III 15·2 *mm.*; IV 17·3 *mm.*

Cephalothorax fulvo-rufescens sublevis fulvo-nigroque longe setosus, area oculorum nigra. Abdomen breviter ovatum, fusco-testaceum longe et crebre fulvo-sericeo hirsutum. Chelæ, sternum, pedes-maxillares, pedesque fulva, pedes extremitates versus obscuriores. Pedes 1 tibia patella non multô longiore haud incrassata, intus prope apicem calcare unico simplici ad basin crasso ad apicem abrupte graciliore, leviter uncato armata, inferne ad marginem exteriorem aculeis trinis gracilibus uniseriatis munita. Metatarso mutico. Pedes postici fere mutici.

Port Blair.

Un seul exemplaire mâle en très mauvais état auquel manquent les pattes-mâchoires et les pattes de la troisième paire.

NOTA.—La collection renferme en outre un certain nombre de jeunes araignées, qui ne sout pas en état d' être décrites. Ces espèces appartiennent aux genres *Homalattus* Wh., *Oxyopes* Latr., *Argiope* Sav., *Nephila* Leach, *Epeira* Walck., *Meta* C. Koch, *Hersilia* Sav., *Chiracanthium* C. Koch.

XX.—*A Memoir on Plane Analytic Geometry.*—*By* ASUTOSH MUKHOPADHYAY, M. A., F. R. A. S., F. R. S. E. *Communicated by* THE HON'BLE MAHENDRALAL SIRCAR, M. D., C. I. E.

[Received October 27th;—Read November 2nd, 1887.]

(With three Wood-cuts.)

CONTENTS.

§. 1. Introduction; object and scope of the memoir.

§. 2. Basis of analytical geometry; relation between analysis and geometry.

§§. 3—5. The Right Line:

- (§. 3). The Line at Infinity.
- (§. 4). Coordinates of intersection of two lines given by the general equation of the second degree: the Point-function.
- (§. 5). Area of triangle formed by any line with two lines given by the general equation.

§§. 6—7. The circle.

- (§. 6). Meaning of the constants in the equation of a circle.
- (§. 7). Chords and tangents of circles and conics; geometrical meaning of Burnside's Equation.

§§. 8—15. The general equation of the second degree in Cartesian coordinates.

- (§. 8). Preliminary remarks on the general equation.
- (§. 9). Transformation of the equation; the Asymptotic Constant.
- (§. 10). Invariants and Covariants of a single conic.
- (§. 11). Lengths of axes and area of a conic.
- (§. 12). Asymptotes of the conic.
- (§. 13). Equations for the eccentricity of the conic.
- (§. 14). The Director-circle in rectangular and oblique coordinate-axes.
- (§. 15). Reduction of the general equation to the asymptotes as coordinate-axes.

§§. 16—20. Laplace's linear equation to a conic.

- (§. 16). Genesis of Laplace's equation.
- (§. 17). Meaning of the constants.
- (§. 18). Elliptic motion.
- (§. 19). Geometric interpretation.
- (§. 20). Eccentricity from Laplace's equation.

§. 21. Area of triangle formed by two tangents to a conic and the chord of contact; various applications.

§§. 22—23. Theorem on the inclination of tangents.

- (§. 22). Formula for the inclination of tangents to conics and of their chord of contact, to any line.
- (§. 23). Applications of the theorem; verification.

§. 24. Generation of similar conics.

§. 25. On a system of three parabolic envelopes.

§§. 26—27. **Reciprocal polars.**
  - **(§. 26). Reciprocal of central conic.**
  - **(§. 27). Reciprocal of evolute of certain curves including conics.**

§§. 28—29. **Theorems on central conics.**
  - **(§. 28). Properties of the ellipse.**
  - **(§. 29). Properties of confocals.**

§§. 30—31. **Theorems on the parabola.**
  - **(§. 30). A dynamical problem.**
  - **(§. 31). Applications to the parabola.**

§. 32. **A geometrical locus.**

§. 1. *Introduction.*

§. 1. **Object and Scope.**—It is my object in the present paper to bring together a number of theorems in plane analytic geometry which have accumulated in my hands during my study of that subject. Some of the simpler of these theorems have already been given in my Lectures on Plane Analytic Geometry, now in course of delivery at the Indian Association for the Cultivation of Science; a few have been ennunciated elsewhere without demonstration; most of the propositions, however, are here published for the first time. I believe that either the theorems themselves, or the methods of establishing them are original; and, except in a very few instances where I have inserted well-known results for the sake of avoiding disconnectedness, I have considered them either for the purpose of giving a proof simpler and more complete than that usually given, or with a view to throw light on the connection between the various parts of the subject. As the different sections of this paper are, to a great extent, practically independent of each other, for the sake of facility of reference, an outline of the principal topics discussed is added above.[*]

§. 2. *Basis of Analytical Geometry.*

§. 2. **Analysis and Geometry.**—The notion of either space or number, or of both, lies at the root of every department of mathematics. Analysis is the science of number; geometry is the science of space; but, as space is homogeneous, and, as every homogeneous substance can, by the choice of a unit, be represented by a number, space can be, for mathematical purposes, represented by numbers; hence, the *possibility* of applying analytical methods to geometrical investigations, and of founding a science of analytical geometry. This possibility was first *realized* into practice by the illustrious French mathematician René Descartes, who invented the method of coordinates. With respect to this method, there are two points which ought to be most carefully noticed. In the first place, to determine the position of any point, we must choose an origin, and, then, fix the position of the point by its coordinates, which may be defined to be independent quantities of the same order which fix the position of a point; we see, then, that the two essentially distinct ideas of origin and coordinates are fundamental in this theory; and, if we consider the matter for a moment, we find that the same two ideas are ever present in every system of coordinates that we may choose. Thus, looking to a comparatively modern part of the subject, the theory of Elliptic Coordinates, we see that the position of any point is determined by the lengths of the semi-axes of the conics which can be drawn through that point confocal to a given conic, called the primitive conic; here, then, the point-origin of the Cartesian system has been replaced by the fundamental conic, and the ordinate and abscissa have been replaced by the semi-axes of two conics. Hence, we conclude that in every system, we must have an origin, which is, as it were, a unit or symbol of reference, and which may be a point or a conic, or any other figure, according to the system we choose; and, having fixed our origin, we determine the position of a point by coordinates, which may be lines straight or curved, or any other geometrical figure; the only essential ideas being those of a symbol of reference, and of the independence of the quantities which fix the position of the point relatively to that origin or symbol of reference.

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[*] **For a full analysis of this paper, see the Proceedings for 1887, pp. 232-235.**

Having thus fixed the position of a point, we next consider how to represent a curve. A curve is defined to be an assemblage of points arranged according to a definite law; the equation of a curve, therefore, is the analytical representation of that geometrical relation which must subsist between the coordinates of a point, in order that that point may be on the given curve. In other words, the equation of a curve may be defined to be the analytical representation of some geometrical property of the curve; and, as a curve has an infinite number of geometrical properties, the question naturally suggests itself whether the analytical representation of each of these properties will give a different equation of the curve. As a matter of fact, we do know that, in whatever way we may derive the equation of a curve, we are led to equations which are apparently different from each other, but which are really not distinct, and which may all be made to coincide by suitable transformations. Indeed, if the reverse had been the case, it would have been manifestly impossible to create a science of analytic geometry; and the reason why all the equations of a curve are really identical is a simple outcome of the fact that all the innumerable geometrical properties of any curve are dependent on each other: the truth of any one being assumed, the others can be deduced from it as necessary mathematical consequences. We see, therefore, that though a curve has an infinite number of geometrical properties, it can have only one equation, and this accords with the great Law of Nature that, *in every natural system, there can be only one relation between the component parts.* This, then, is the second fact which made possible the very existence of Analytical Geometry.

From what has been pointed out above, it is evident that the equation of a curve is, as it were, a convenient repository of all theorems connected with it, and all its properties may be established by algebraic transformation of the equation. From this, as well as from the fundamental relation between analysis and geometry noted above, it is clear that, to every algebraic transformation, there corresponds a geometrical fact, and *vice versâ*. Take, for example, the subject of the transformation of coordinates. We all know that transformation is of two kinds; it may be a change to new axes, parallel to the old ones, through a new origin, which may conveniently be termed **Translation-transformation**; or, again, the transformation may be to new axes, inclined to the old ones, through the old origin, which may be called **Rotation-transformation**; if, in any case, both these kinds are combined, we may call it **Compound-transformation**; and from the known algebraical formulæ for compound transformation, it is clear that this geometrical process is nothing but the exact counterpart of the algebraic process of linear transformation. Similarly, it may be remarked that the problem of inversion is a case of quadric transformation.

§§. 3—5. *The Right Line.*

§. 3. **The Line at Infinity.**—The equation of any line being

$$\frac{x}{a}+\frac{y}{b}=1,$$

where a, b are the intercepts on the co-ordinate axes, the equation of the line which is at an infinite distance from the origin is obtained by substituting herein

$$a=b=\infty,$$

which gives

$$1=0.$$

Without any real change of generality, we may write this

$$\lambda=0$$

where λ is any constant; this, then, is the equation of the line at infinity; it will be of use in determining the asymptotes of the conic given by the general equation of the second degree (§. 12).

§. 4. **Coordinates of intersection of two lines.** The following method of investigating the condition that the general equation of the second degree

$$ax^2+2hxy+by^2+2gx+2fy+c=0$$

may represent two right lines, is shorter than the proofs usually given, and has, besides, the advantage of furnishing at once the coordinates of the point of intersection of the lines represented by the equation.

Let (x', y') be the point of intersection of the lines; removing our origin to this point, the equation becomes

$$ax^2+2hxy+by^2+2g'x+2f'y+c'=0 \qquad \ldots\ldots\ldots\ldots (1)$$

where

$$\begin{aligned} g' &= ax'+hy'+g, \\ f' &= hx'+by'+f, \\ c' &= ax'^2+2hx'y'+by'^2+2gx'+2fy'+c. \end{aligned}$$

But the equation (1) now represents a pair of lines through the origin, and, as such, it ought to be homogeneous in the second degree; therefore, each of the quantities g', f', c' must vanish separately, which gives

$$ax'+hy'+g=0 \qquad \ldots\ldots\ldots\ldots (2)$$

$$hx'+by'+f=0 \qquad \ldots\ldots\ldots\ldots (3)$$

$$ax'^2+2hx'y'+by'^2+2gx'+2fy'+c=0 \qquad \ldots\ldots\ldots\ldots (4)$$

Multiplying (2) by x', (3) by y', and subtracting the sum of the products from (4), we get

$$gx'+fy'+c=0 \qquad \ldots\ldots\ldots\ldots (5)$$

From (2) and (3), we have

$$x'=\frac{hf-bg}{ab-h^2}, \quad y'=\frac{hg-af}{ab-h^2}, \qquad \ldots\ldots\ldots\ldots (6)$$

which are, accordingly, the coordinates of the point of intersection of the lines represented by the given equation. Eliminating x', y', from (2), (3), (5), we have the condition that the discriminant must vanish in order that the equation may represent two right lines, *viz.*,

$$\begin{vmatrix} a & n & g \\ h & b & f \\ g & f & c \end{vmatrix} = 0 \qquad \ldots\ldots\ldots\ldots (7)$$

As the equation

$$ax^2+2hxy+by^2+2gx+2fy+c=0$$

is transformed to

$$ax^2+2hxy+by^2=0$$

when the axes are removed to the point of intersection of the lines, it follows that, as the angle between the lines is not altered in magnitude by the transformation, the angle between the lines given by the general equation of the second degree is the same as that between the lines

$$ax^2+2hxy+by^2=0.$$

The quantity c', which occurs in this investigation, may be called the point-function of the conic.

Definition.—The **point-function** of any curve with respect to any point is the function which is obtained by substituting the coordinates of that point in the expression the vanishing of which gives the equation of the curve. It is clear that the point-function with respect to any point on the curve itself is zero, while the point-function with respect to the origin is the absolute term in the equation of the curve.

§. 5. **Area of a Triangle.**—If the general equation of the second degree

$$ax^2+2hxy+by^2+2gx+2fy+c=0 \qquad \ldots\ldots\ldots\ldots \ (8)$$

represents a pair of right lines, to investigate the area of the triangle formed by these two lines with the line

$$lx+my=n. \qquad \ldots\ldots\ldots\ldots \ (9)$$

Remove the origin to the point

$$\left(\frac{hf-bg}{ab-h^2},\ \frac{hg-af}{ab-h^2}\right),$$

which is the point of intersection of the pair of lines represented by (8). The two equations then become

$$ax^2+2hxy+by^2=0 \qquad \ldots\ldots\ldots\ldots \ (10)$$

and

$$l\left(x+\frac{hf-bg}{ab-h^2}\right)+m\left(y+\frac{hg-af}{ab-h^2}\right)=n,$$

or

$$lx+my=p, \qquad \ldots\ldots\ldots\ldots \ (11)$$

where

$$p=\frac{l(hf-bg)+m(hg-af)+n(h^2-ab)}{h^2-ab} \ldots\ldots\ldots\ldots \ (12)$$

Now, suppose that the lines in (10) are made up of the two

$$y-m_1x=0,\ y-m_2x=0, \qquad \ldots\ldots\ldots\ldots \ (13),\ (14)$$

so that

$$m_1+m_2=-\frac{2h}{b} \qquad \ldots\ldots\ldots\ldots \ (15)$$

$$m_1\ m_2=\frac{a}{b} \qquad \ldots\ldots\ldots\ldots \ (16)$$

whence

$$m_1^2+m_2^2=\frac{4h^2-2ab}{b^2} \qquad \ldots\ldots\ldots\ldots \ (17)$$

The coordinates of the point of intersection of (11) with (13) are given by

$$x=\frac{p}{l+mm_1},\ y=\frac{m_1 p}{l+mm_1}.$$

If, therefore, δ_1 is the length of the line intercepted between the new origin (which is the point of intersection of the pair of lines) and the point of intersection of (11) with (13), we have

$$\delta_1{}^2=\frac{p^2(1+m_1{}^2)}{(l+mm_1)^2} \qquad \dots\dots\dots\dots \ (18)$$

Similarly, if δ_2 be the length of the line intercepted between the new origin and the point of intersection of (11) with (14), we have

$$\delta_2{}^2=\frac{p^2(1+m_2{}^2)}{(l+mm_2)^2} \qquad \dots\dots\dots\dots \ (19)$$

Hence, from (18) and (19), we get

$$\delta_1{}^2\delta_2{}^2=\frac{p^4\left\{1+(m_1{}^2+m_2{}^2)+m_1{}^2m_2{}^2\right\}}{\left\{l^2+lm(m_1+m_2)+m^2.m_1m_2\right\}^2}.$$

Therefore, substituting for m_1, m_2 from the system of equations (15), (16), (17), we get

$$\delta_1\delta_2=\frac{p^2\sqrt{\left\{4h^2+(a-b)^2\right\}}}{am^2-2hml+bl^2}. \qquad \dots\dots\dots\dots \ (20)$$

But, if ϕ be the angle between the lines given by (10), we have

$$\tan\phi=\frac{2\sqrt{h^2-ab}}{a+b},$$

whence .... $\sin\phi=\dfrac{2\sqrt{h^2-ab}}{\sqrt{\left\{4h^2+(a-b)^2\right\}}}$,

so that the area of the triangle in question is

$$\begin{aligned}&=\tfrac{1}{2}\,\delta_1\,\delta_2\sin\phi\\ &=\frac{p^2\sqrt{h^2-ab}}{am^2-2hml+bl^2}\\ &=\frac{\left\{l(hf-bg)+m(hg-af)+n(h^2-ab)\right\}^2}{(h^2-ab)^{\frac{3}{2}}\,(am^2-2hml+bl^2)},\end{aligned}$$

by substituting for p from (12). Hence, finally, using the determinant notation, and altering the sign of n, we have the general

Theorem.—If the general equation of the second degree

$$ax^2+2hxy+by^2+2gx+2fy+c=0$$

represents a pair of right lines, the area of the triangle formed by this pair with the line

$$\lambda x+\mu y+\nu=0$$

is

$$\frac{\begin{vmatrix} a & h & \lambda \\ h & b & \mu \\ g & f & \nu \end{vmatrix}^2}{\begin{vmatrix} h & b \\ a & h \end{vmatrix}^{\frac{3}{2}}\begin{vmatrix} h & b & \mu \\ a & h & \lambda \\ \lambda & \mu & 0 \end{vmatrix}} \quad \ldots \text{ (21)}$$

The length of the portion of $\lambda x+\mu y+\nu=0$ which is intercepted between the pair of lines is also easily found; for, from (12), the perpendicular from the point of intersection of the pair of lines on

$$\lambda x+\mu y+\nu=0$$

is at once seen to be

$$\frac{\begin{vmatrix} a & h & \lambda \\ h & b & \mu \\ g & f & \nu \end{vmatrix}}{\left\{(h^2-ab)(\lambda^2+\mu^2)^{\frac{1}{2}}\right\}} \quad \ldots\ldots\ldots\ldots \text{ (22)}$$

Hence, the length of the intercepted portion is

$$\frac{\begin{vmatrix} \lambda & -\mu \\ \mu & \lambda \end{vmatrix}^{\frac{1}{2}}}{\begin{vmatrix} h & b \\ a & h \end{vmatrix}^{\frac{1}{2}}} \cdot \frac{\begin{vmatrix} a & h & \lambda \\ h & b & \mu \\ g & f & \nu \end{vmatrix}}{\begin{vmatrix} h & b & \mu \\ a & h & \lambda \\ \lambda & \mu & 0 \end{vmatrix}} \text{ (23)}$$

The product of the two sides is, by a glance at (20), written down to be

$$\frac{\begin{vmatrix} 2h & a-b \\ b-a & 2h \end{vmatrix}^{\frac{1}{2}} \begin{vmatrix} a & h & \lambda \\ h & b & \mu \\ g & f & \nu \end{vmatrix}^2}{\begin{vmatrix} h & a \\ b & h \end{vmatrix}^2 \begin{vmatrix} h & b & \mu \\ a & h & \lambda \\ \lambda & \mu & 0 \end{vmatrix}} \quad \ldots \text{ (24)}$$

As an application of the formula in (21), we can find the area of the parallelogram formed by the two lines

$$ax^2+2hxy+by^2+2gx+2fy+c=0$$

with

$$ax^2+2hxy+by^2=0$$

which are two lines through the origin parallel to the first pair. By subtracting the equations, we see that

$$2gx+2fy+c=0$$

represents that diagonal of the parallelogram which does not pass through the origin. The area of the triangle formed by this diagonal with the first pair is

$$\frac{\left\{2g\,(hf-bg)+2f\,(hg-af)-c\,(h^2-ab)\right\}^2}{4(h^2-ab)^{\frac{3}{2}}(af^2-2fgh+bg^2)},$$

and that formed with the second pair is

$$\frac{c^2\,(h^2-ab)^2}{4(h^2-ab)^{\frac{3}{2}}\,(af^2-2fgh+bg^2)}.$$

But, since the discriminant vanishes, it is clear that

$$2g(hf-bg)+2f\,(hg-af)-2c\,(h^2-ab)=0$$

$$af^2-2fgh+bg^2=c\,(ab-h^2).$$

Hence, adding the above expressions, the area of the quadrilateral in question is found to be

$$\frac{1}{2}\,\frac{c}{\sqrt{h^2-ab}}.$$

It may be noted that this expression is only apparently independent of f, g, for the vanishing of the discriminant shews that a, b, c, h are functions of f and g.

§§. 6—7. *The Circle.*

§. 6. **Meaning of the Constants in the Equation of a Circle.**—The equation of a circle

$$x^2+y^2+2gx+2fy+c=0$$

being thrown into the form

$$(x-g)^2+(y-f)^2=g^2+f^2-c,$$

the quantities $-g$, $-f$ are seen to be the coordinates of the centre, while, if r be the radius, we have

$$r^2=g^2+f^2-c.$$

To determine the geometric meaning of c, let δ be the distance of the centre from the origin, and t, either of the tangents drawn from the origin to the circle; then,

$$\delta^2=r^2+t^2$$

and, also,

$$\delta^2=f^2+g^2$$

$$r^2=f^2+g^2-c$$

which give

$$c=t^2. \qquad \ldots\ldots\ldots\ldots (25)$$

Hence, c denotes the square of the tangent drawn from the origin to the circle. We thus infer that, if the equations of a system of circles agree in either f or g, the locus of their centres is a right line parallel to a given line at a given distance from it, and their common chords are parallel, being all perpendicular to this given line; if both f and g are the same in all the equations, the system is concentric; if c alone is the same in all the equations, the circles are such as can be intersected orthogonally by a circle of radius $\sqrt{c}$, described round the origin as centre; and this shews at once that as a system of co-axal circles can be orthogonally intersected, their equations must necessarily be of the form

$$x^2+y^2-2kx = \pm\delta^2,$$

where δ is constant, but k variable.

The geometric meaning of c also furnishes the length of the tangent drawn from any point to a circle, for, the equation of the circle being

$$x^2+y^2+2gx+2fy+c=0,$$

and the point from which tangents are drawn being (x', y'), remove the origin to this point; then, the new absolute term is clearly the point-function of the circle with respect to the point (x', y'), and this, therefore, is the length of the tangent sought. It follows as a consequence of this, that the geometric meaning of the equation of the circle is that, if the length of the tangent drawn from any point to a circle vanishes, that point must be on the curve itself.

§. 7. **Chords and Tangents of Circles and Conics.**—The following equation of the chord joining the two points (x', y'), $(x'', y'',)$ on the circle

$$x^2+y^2=r^2 \qquad \text{............} \quad (26)$$

is due to Professor Burnside, (Salmon's *Conics*, §. 85, Ed. 1879, p. 80),

$$(x-x')(x-x'')+(y-y')(y-y'')=x^2+y^2-r^2 \text{............} \quad (27)$$

It is easily verified that this is actually the equation of the chord; the following geometrical interpretation, however, shows the genesis of the equation.

On the line joining the points (x', y'), (x'', y'') as diameter, describe a circle; any point (x, y) on this circumference is such that the lines joining (x, y), (x', y'), and (x, y), (x'', y''), include a right angle; this condition, expressed analytically, gives for the equation of the circle

$$(x-x')(x-x'')+(y-y')(y-y'')=0 \quad \text{............} \quad (28)$$

The chord in question may now be regarded as the common chord of the two circles represented by (26) and (28); and then, from the elementary principle that $S+kS'=0$ represents any locus through the common points of $S=0$, $S'=0$, we at once write down Burnside's equation (27), the proper value of k being easily seen to be given by

$$1+k=0.$$

The generalisation to the conic given by the general equation

$$ax^2+2hxy+by^2+2gx+2fy+c=0 \quad \text{............} \quad (29)$$

is easy, *viz.*,

$$a(x-x')(x-x'')+2h(x-x')(y-y'')+b(y-y')(y-y'')=0 \qquad (30)$$

represents any conic through (x', y'), (x'', y''), which may, it is useful to notice, satisfy three other conditions: and the chord in question, being the common chord of (29) and (30), must have for its equation

$$\begin{aligned} &a(x-x')(x-x'')+2h(x-x')(y-y'')+b(y-y')(y-y'') \\ &= ax^2+2hxy+by^2+2gx+2fy+c \qquad \ldots\ldots\ldots\ldots (31) \end{aligned}$$

I have not, however, been able to find if the conics (29) and (30) are connected by any very special or peculiar relation: their centres are not coincident; the centre of (30) is not on the chord whose equation is required; their asymptotes, however, include equal angles, and their axes are parallel; in fact, they are similar and similarly situated, and, therefore, necessarily equi-eccentric.

The equation of the tangent *at* any point may be deduced, as usual, from the equation of the chord; or we may first obtain by Joachimsthal's method the equation of the pair of tangents *from* an external point, and thence obtain the equation of the tangent *at* any point of the curve. The same equation, however, may be obtained by transformation, if we know the equation of the tangents from the origin; thus, the conic being

$$ax^2+2hxy+by^2+2gx+2fy+c=0$$

and (x', y') the external point, remove the origin to this point, so that the conic becomes

$$ax^2+2hxy+by^2+2g'x+2f'y+c'=0,$$

where the values of f', g', c' are the same as in §. 4. If now $y=mx$ be any line through the new origin, it will touch the conic if the quadratic in x,

$$(a+2hm+bm^2)x^2+2(g'+f'm)x+c'=0,$$

has equal roots, which condition gives

$$c'(a+2hm+bm^2)=(g'+f'm)^2,$$

and by substituting

$$m=\frac{y}{x},$$

we have for the equation of the tangents, referred to the new origin,

$$c'(ax^2+2hxy+by^2)=(g'x+f'y)^2,$$

which may be written

$$c'(ax^2+2hxy+by^2+2g'x+2f'y+c')=(g'x+f'y+c')^2.$$

Reverting to our old axes, we have at once the equation in the form

$$(\text{Conic})\times(\text{Point-function})=(\text{Polar})^2,$$

which is, of course, the same equation as that obtained by Joachimsthal's method.

§§. 8—15. *The General Equation of the Second Degree.*

§. 8. **Preliminary.**—The discussion of the general equation of the second degree deservedly occupies an important position in the application of analytical geometry to the theory of lines of the second order; for, in analytical geometry properly so called, the question of degree or class is of fundamental importance, and the curves of the second degree should be called lines of the second order, and not conic sections, the proper point of view from which their properties ought to be studied being the fact that the equation representing them is of the second degree, and not the other fact that they are sections of a cone and have foci and directrices. The truly logical order of treating the subject is first to have a chapter on the equation of the first degree, containing the properties of right lines, then a chapter on the general equation of the second degree, and, as distinctly subsidiary to this, chapters on the circle, the ellipse, and the other conics. We proceed, then, to give the barest outline of such a systematic discussion as is indicated here. It may usefully be noted that the object of the discussion is twofold, *viz.*, in the first place, the problem is how to transform the equation to its simplest forms, and thus to classify the different kinds of conics; in the second place, we obtain some general formulæ for such properties as are common to all conics.

§. 9. **Transformation of the Equation.**—The general equation of the second degree being

$$S = ax^2 + 2hxy + by^2 + 2gx + 2fy + c = 0, \quad \ldots\ldots\ldots\ldots \quad (32)$$

first change the origin to (x', y'), so that the equation becomes

$$ax^2 + 2hxy + by^2 + 2g'x + 2f'y + c' = 0$$

where

$$g' = \left(\frac{dS}{dx}\right)_{\substack{x=x' \\ y=y'}} = ax' + hy' + g$$

$$f' = \left(\frac{dS}{dy}\right)_{\substack{x=x' \\ y=y'}} = hx' + by' + f$$

$$c' = \text{Point-function.}$$

If, then, we make $g' = f' = 0$, that is, if we have for the coordinates of the new origin

$$x' = \frac{hf - bg}{ab - h^2}, \quad y' = \frac{hg - af}{ab - h^2}, \quad \ldots\ldots\ldots\ldots \quad (33), (34)$$

the transformed equation is

$$ax^2 + 2hxy + by^2 + \frac{\Delta}{ab - h^2} = 0 \quad \ldots\ldots\ldots\ldots \quad (35)$$

where Δ is the discriminant (§. 4). In order that this transformation may be real and possible, we must have $(ab - h^2)$ different from zero.

The first point of departure, then, in the classification of conics, depends on the equation

$$ab - h^2 > \text{ or } < 0.$$

The case in which $h^2 = ab$ does not admit of the above transformation, and it must be treated separately (see Carr's Synopsis of Pure Mathematics, §§. 4430—4443). In the case where $(ab - h^2)$ does not vanish, we proceed further, as follows.' Turn the axes about the new origin through an angle θ, where θ is given by

$$\tan 2\theta = \frac{2h}{a-b}, \qquad \ldots\ldots\ldots\ldots \quad (36)$$

and the new equation becomes

$$Ax^2 + By^2 + \frac{\Delta}{ab - h^2} = 0 \qquad \ldots\ldots\ldots\ldots \quad (37),$$

where A, B are certain constants to be determined hereafter. This equation may be put into the form

$$\frac{x^2}{\alpha^2} + \frac{y^2}{\beta^2} = 1 \qquad \ldots\ldots\ldots\ldots \quad (38)$$

if

$$\frac{1}{\alpha^2} = -\frac{A}{Q}, \quad \frac{1}{\beta^2} = -\frac{B}{Q} \qquad \ldots\ldots\ldots\ldots \quad (39), (40)$$

and

$$Q = \frac{\Delta}{ab - h^2}. \qquad \ldots\ldots\ldots\ldots \quad (41)$$

Definition.—The quantity which we have denoted here by Q, we will call the **Asymptotic Constant,** the reason for which name will appear in §. 12. The quantities α, β are called the semi-axes of the conic.

§. 10. **Invariants.**—In the last section, we transformed the general equation of the second degree to its simplest form (38); but, we did not calculate the quantities α, β which depend on A, B. As a rule, the calculation of these quantities in every particular case is a laborious task; we, therefore, find out some functions of the coefficients which remain unaltered by transformation, and which are, accordingly, called Invariants of the conic. These invariants may be of different classes; thus, there are certain quantities which remain unaltered for a translation-transformation, and which may appropriately be called **Translation-invariants**; to this class belong a, h, b. Again, there are certain quantities which remain unaltered for a rotation-transformation, and which may, accordingly, be called **Rotation-invariants**; thus, the absolute term is a rotation-invariant; but the most important of these invariants are embodied in Dr. Boole's theorems that the quantities

$$\frac{a + b - 2h \cos \omega}{\sin^2 \omega}, \quad \frac{ab - h^2}{\sin^2 \omega} \qquad \ldots\ldots\ldots\ldots \quad (42), (43)$$

belong to this class (Salmon's *Conics*, §. 159, Ed. 1879, p. 159). Again, as we have seen that a, b, h are translation-invariants, it follows that

$$\frac{a+b-2h\cos\omega}{\sin^2\omega}, \quad \frac{ab-h^2}{\sin^2\omega}$$

are invariants for the compound transformation as well, and may, accordingly, be called **General Invariants.** We shall now proceed to investigate, by a process analogous to that employed by Dr. Boole, certain invariants which include as particular cases those noticed above.

Suppose that by a rotation-transformation the equation

$$ax^2+2hxy+by^2+2gx+2fy+c=0$$

assumes the form

$$AX^2+2HXY+BY^2+2GX+2FY+C=0.$$

Then, by the same transformation

$$x^2+y^2+2xy\cos\omega$$

is altered into

$$X^2+Y^2+2XY\cos\Omega,$$

because each of these expressions denotes the distance of the same point from the fixed origin. Hence, we have

$$\begin{aligned}&(a+\lambda)x^2+2(h+\lambda\cos\omega)xy+(b+\lambda)y^2+2gx+2fy+c\\ &=(A+\lambda)X^2+2(H+\lambda\cos\Omega)XY+(B+\lambda)Y^2+2GX+2FY+C.\end{aligned}$$

Each side of this identity will resolve itself into linear factors for the same value of λ; hence, equating the discriminant of each side to zero, we have the two equations

$$\begin{aligned}&c\sin^2\omega.\,\lambda^2+\Big\{c(a+b-2h\cos\omega)-(f^2+g^2-2fg\cos\omega)\Big\}\lambda\\ &\qquad+abc+2fgh-af^2-bg^2-ch^2=0\\ &C\sin^2\Omega.\,\lambda^2+\Big\{C(A+B-2H\cos\Omega)-(F^2+G^2-2FG\cos\Omega)\Big\}\lambda\\ &\qquad+ABC+2FGH-AF^2-BG^2-CH^2=0.\end{aligned}$$

As these quadratics in λ must be identical, we have, by equating the coefficients of corresponding terms, the two relations

$$\begin{aligned}&\frac{a+b-2h\cos\omega}{\sin^2\omega}-\frac{f^2+g^2-2fg\cos\omega}{c\sin^2\omega}\\ &=\frac{A+B-2H\cos\Omega}{\sin^2\Omega}-\frac{F^2+G^2-2FG\cos\Omega}{C\sin^2\Omega}, \quad \text{.........} \quad (44)\end{aligned}$$

$$\frac{abc+2fgh-af^2-bg^2-ch^2}{c\sin^2\omega}=\frac{ABC+2FGH-AF^2-BG^2-CH^2}{C\sin^2\Omega}. \quad (45)$$

If $f=0$, $g=0$, these equations furnish Dr. Boole's invariants. As we have noticed that c is a rotation-invariant, these results shew that the functions

$$\Big\{c(a+b-2h\cos\omega)-(f^2+g^2-2fg\cos\omega)\Big\}\div\sin^2\omega \quad \text{.........} \quad (46)$$

$$\frac{\Delta}{\sin^2\omega}. \qquad \ldots\ldots\ldots\ldots (47)$$

are rotation-invariants.

In order to see if any of these is a general invariant, we must examine whether they are translation-invariants. It will be found on examination that the first is not a translation-invariant, while for the second we know that, by a translation-transformation, the equation

$$ax^2+2hxy+by^2+2gx+2fy+c=0$$

is transformed into

$$a'x^2+2h'xy+b'y^2+2g'x+2f'y+c'=0,$$

where

$$a'=a,\ h'=h,\ b'=b,$$

which, by the way, shews that the part of the second degree in the general equation is a covariant for translation-transformation,

and
$$g'=ax'+hy'+g$$
$$f'=hx'+by'+f$$
$$c'=\text{Point-function},$$

from which, by actual calculation, we find that the coefficients of x^2, xy, y^2, x, y in

$$a'b'c'+2f'g'h'-a'f'^2-b'g'^2-c'h'^2$$

all vanish, and the absolute term is Δ. Hence, we infer that Δ is a translation-invariant, and so also is

$$\frac{\Delta}{\sin^2\omega},$$

since ω is unaltered by translation-transformation; thus, from what precedes, we have finally that

$$\frac{\Delta}{\sin^2\omega}$$

is a general invariant of the conic. To sum up, we enumerate below the principal invariants of the general conic.

I. Translation-invariants.

(i). a. (ii). h. (iii). b. (iv). Δ.

II. Rotation-invariants.

(i) Absolute term. (ii) $\dfrac{a+b-2h\cos\omega}{\sin^2\omega}$

(iii) $\dfrac{ab-h^2}{\sin^2\omega}$

(iv) $\dfrac{a+b-2h\cos\omega}{\sin^2\omega}-\dfrac{f^2+g^2-2fg\cos\omega}{c\sin^2\omega}$

(v) $\dfrac{\Delta}{\sin^2\omega}$. (vi) $\dfrac{f^2+g^2-2fg\cos\omega}{c\sin^2\omega}$.

III. General invariants.

(i) $\dfrac{a+b-2h\cos\omega}{\sin^2\omega}$ (ii) $\dfrac{ab-h^2}{\sin^2\omega}$

(iii) $\dfrac{\Delta}{\sin^2\omega}$.

It is clear that since any function of an invariant is an invariant, various invariants may be deduced from these by combining them in different ways or by imposing limiting conditions on them. Thus, for rectangular axes, Δ is a general invariant; and, if we examine the equation

$$ax^2+2hxy+by^2+2fy=0,$$

which denotes a conic referred to a tangent and normal as coordinate-axes, we see that it has the three general invariants, $(a+b)$, $(ab-h^2)$, af^2.

We have shewn above, *by actual calculation*, that the discriminant is a translation-invariant; it is interesting to note that the same result may be obtained as an illustration of Dr. Boole's method. Thus, if by translation-transformation the equation

$$ax^2+2hxy+by^2+2gx+2fy+c=0$$

is transformed into

$$a_1X^2+2h_1XY+b_1Y^2+2g_1X+2f_1Y+c_1=0,$$

the same transformation changes

$$x^2+y^2+2xy\cos\omega$$

into

$$(X-x_1)^2+(Y-y_1)^2+2(X-x_1)(Y-y_1)\cos\omega,$$

whence we have

$$\begin{aligned} &ax^2+2hxy+by^2+2gx+2fy+c+\lambda(x^2+y^2+2xy\cos\omega)\\ &=a_1X^2+2h_1XY+b_1Y^2+2g_1X+2f_1Y+c_1\\ &\quad+\lambda\left\{(X-x_1)^2+(Y-y_1)^2+2(X-x_1)(Y-y_1)\cos\omega\right\}. \end{aligned}$$

Equating the discriminant of the left hand side to zero, we have

$$c\sin^2\omega.\,\lambda^2+\left\{c(a+b-2h\cos\omega)-(af^2+bg^2-2fg\cos\omega)\right\}\lambda+\Delta=0 \quad\ldots\ldots\ldots\ldots (48)$$

If we equate to zero the discriminant of the right hand side, the equation in λ apparently comes out to be a cubic; but the coefficient of λ^3 is found on calculation to be zero, while, in the coefficient of λ^2, the terms involving x_1^2, x_1y_1, y_1^2, x_1, y_1 separately vanish, and the constant is $c\sin^2\omega$; hence the equation may be written

$$c\sin^2\omega.\,\lambda^2+R\lambda+\Delta_1=0. \quad\ldots\ldots\ldots\ldots (49).$$

Therefore, equating coefficients, we have

$$\Delta=\Delta_1,$$

which shews, as before, that Δ is a translation-invariant. It may be noted that, from a comparison of (48) and (49), it is clear that the value of R in (49) is

$$\left\{ c(a+b-2h\cos\omega)-(af^2+bg^2-2fg\cos\omega) \right\},$$

as, indeed, may be verified by direct calculation.

§. 11. **Lengths of axes and area of conic.**—We have shewn above that the semi-axes α, β of a conic are given by (39) and (40), *viz*,

$$\frac{1}{\alpha^2}=-\frac{A}{Q},\quad \frac{1}{\beta^2}=-\frac{B}{Q},$$

and, from the theory of invariants explained above, we have further

$$A+B=\frac{a+b-2h\cos\omega}{\sin^2\omega},\quad AB=\frac{ab-h^2}{\sin^2\omega}\quad \text{.........} \quad (50),\ (51).$$

Hence, if ρ be a semi-axis, we have

$$\rho^4-(\alpha^2+\beta^2)\rho^2+\alpha^2\beta^2=0 \quad \text{...........} \quad (52)$$

where

$$\alpha^2+\beta^2=-Q\left(\frac{1}{A}+\frac{1}{B}\right),\quad \alpha^2\beta^2=\frac{Q^2}{AB}.$$

Substituting in (52) from (50) and (51), and putting from (41)

$$Q=\frac{\Delta}{ab-h^2},$$

we get

$$\rho^4+\frac{\Delta(a+b-2h\cos\omega)}{(ab-h^2)^2}\rho^2+\frac{\Delta^2\sin^2\omega}{(ab-h^2)^3}=0, \quad \text{......} \quad (53)$$

which is, accordingly, the equation furnishing the semi-axes of the given conic; and, as it is a quadratic in ρ^2, it shews that there are *four* semi-axes, which may be grouped into two pairs, the two axes in each pair being equal in magnitude but opposite in direction. It follows from (53) that, if $\rho_1{}^2$, $\rho_2{}^2$ be the roots of the quadratic in ρ^2, the area of the conic is

$$\pi\rho_1\rho_2=\frac{\pi\Delta\sin\omega}{(ab-h^2)^{\frac{3}{2}}} \quad \text{...........} \quad (54)$$

Again, it is clear that A and B will have the same sign or different signs, according as AB is positive or negative, that is, according as AB is greater or less than zero; hence, since A and B in the equation (37)

$$Ax^2+By^2+\frac{\Delta}{ab-h^2}=0$$

are connected by the relation (51)

$$AB=\frac{ab-h^2}{\sin^2\omega},$$

it follows that A and B, and thence necessarily α^2, β^2 in the equation (38)

$$\frac{x^2}{\alpha^2}+\frac{y^2}{\beta^2}=1,$$

will have the same sign or opposite signs, according as $(ab-h^2) > $ or < 0, or according as the curve is an ellipse or hyperbola. This completes the classification of conics. (§. 9).

§. 12. **Asymptotes.**—In the ordinary text-books (cf. Smith's *Conics*, §. 174, Ed. 1882, p. 187), the method of finding the equation of the asymptotes of the general conic is given as follows: it is first proved that the asymptotes of the conic in the particular case

$$\frac{x^2}{a^2}-\frac{y^2}{b^2}=1$$

are given by

$$\frac{x^2}{a^2}-\frac{y^2}{b^2}=0,$$

and thence it is inferred that, in the general case, the equations of the conic and asymptotes must differ only by a constant; the logic of this reasoning is, to say the least, hardly satisfactory; the following method is both easy and rigorously logical.

The asymptotes being tangents to the conic at infinity, they may be regarded as a pair of lines passing through the points of intersection of the conic and the line at infinity. Now, the equation of the conic being

$$S \equiv ax^2+2hxy+by^2+2gx+2fy+c=0,$$

and that of the line at infinity having been shewn (§. 3) to be

$$\lambda=0,$$

any conic through their common points is

$$S+\lambda=0;$$

and, in order that this may be a pair of lines, its discriminant must vanish, whence, as usual,

$$\lambda=-Q=-\frac{\Delta}{ab-h^2},$$

and the asymptotes are given by

$$S=Q,$$

which shews that the **asymptotic constant** in (41) is a constant which must be equated to S, to furnish the equation of the asymptotes.

The above process may be represented in a modified form as follows; the conic

$$ax^2+2hxy+by^2+2gx+2fy+c=0$$

being transformed to the centre, becomes

$$ax^2+2hxy+by^2+\frac{\Delta}{ab-h^2}=0,$$

whence it at once follows that the quantity to be added to the right hand side of this equation to give the asymptotes is the asymptotic constant. Now, if we transform back to our old axes, the left hand side becomes

$$ax^2+2hxy+by^2+2gx+2fy+c,$$

while, Δ and $(ab-h^2)$ being translation-invariants, the right hand side remains unaltered, and the equation sought is accordingly

$$S=\frac{\Delta}{ab-h^2}. \qquad \text{............ (55)}$$

It follows from (6) that the point of intersection of the asymptotes in (55) coincides with the centre of the conic, and that, accordingly, the centre is the pole of the line at infinity. It is also clear that the asymptotes will be at right angles to each other and the conic will be a rectangular hyperbola, if $(a+b)=2h \cos \omega$, in oblique coordinates, and $(a+b)=0$ in rectangular coordinates.

§. 13. **Eccentricity.**—The eccentricity‘ may be calculated in different ways according to the definition we employ.

First method.

$$e^2=\frac{\alpha^2-\beta^2}{\alpha^2},$$

where α, β are the semi-axes of the conic. We have

$$2-e^2=\frac{\alpha^2+\beta^2}{\alpha^2},$$

$$1-e^2=\frac{\beta^2}{\alpha^2},$$

which give

$$\frac{(2-e^2)^2}{1-e^2}=\frac{(\alpha^2+\beta^2)^2}{\alpha^2\beta^2},$$

and this, by substitution from (39) and (40), becomes

$$\frac{(2-e^2)^2}{1-e^2}=\frac{(A+B)^2}{AB}. \qquad \text{........ (56)}$$

But, from the invariants (42) and (43), we have

$$A+B=\frac{a+b-2h\cos\omega}{\sin^2\omega},$$

$$AB=\frac{ab-h^2}{\sin^2\omega},$$

so that equation (56) becomes

$$\frac{(2-e^2)^2}{1-e^2}=\frac{(a+b-2h\cos\omega)^2}{(ab-h^2)\sin^2\omega}, \qquad \text{....... (57)}$$

which is the familiar equation. It is clear from (57) that $(1-e^2)$ and $(ab-h^2)$ are simultaneously positive, zero, or negative; hence, we have

$$e^2 < = > 1$$

according as

$$h^2 < = > ab,$$

or according as the conic is an ellipse, a parabola, or an hyperbola. In the equilateral hyperbola, we have

$$a+b-2h\cos\omega=0,$$

whence $$e=\sqrt{2}.$$

Second method.

$$e=\sec\frac{\phi}{2},$$

where ϕ is the angle between the asymptotes. The equation of the asymptotes from (55) being

$$ax^2+2hxy+by^2+2gx+2fy+c=\frac{\Delta}{ab-h^2},$$

we have

$$\tan\phi=\frac{2\sin\omega.\sqrt{h^2-ab}}{a+b-2h\cos\omega}. \tag{58}$$

But $$\sec^2\phi=\left(2\cos^2\frac{\phi}{2}-1\right)^{-}$$

$$=\left[\frac{\sec^2\frac{\phi}{2}}{2-\sec^2\frac{\phi}{2}}\right]^2=\left(\frac{e^2}{2-e^2}\right)^2,$$

whence we have

$$\tan^2\phi=\sec^2\phi-1=\left(\frac{e^2}{2-e^2}\right)^2-1=\frac{4(e^2-1)}{(2-e^2)^2}.$$

Therefore, from equation (58),

$$\frac{e^2-1}{(2-e^2)^2}=\frac{(h^2-ab)\sin^2\omega}{(a+b-2h\cos\omega)^2};$$

which is the same equation as (57).

Third method.

The eccentricity may be defined to be the ratio of the distance of any point on the conic from a focus to its distance from the corresponding directrix; the calculation on the basis of this method will come in most appropriately when we presently deal with Laplace's Linear Equation of a Conic (§§. 16—20; see, in particular, §. 20).

§. 14. **Director-circle.**—The director-circle of

$$S\equiv ax^2+2hxy+by^2+2gx+2fy+c=0$$

being the locus of intersection of orthogonal tangents, its equation in rectangular coordinates is known to be

$$(ab-h^2)(x^2+y^2)+2(gb-fh)x+2(fa-hg)y$$
$$+c(a+b)-f^2-g^2=0, \quad \ldots\ldots\ldots\ldots \tag{59}$$

which may also be written in the form

$$D\equiv(a+b)S-(ax+hy+g)^2-(hx+by+f)^2=0 \quad \ldots\ldots\ldots\ldots \tag{60}$$

The centre of the director-circle is seen from (59) to be the point

$$\left(\frac{fh-bg}{ab-h^2},\ \frac{hg-af}{ab-h^2}\right),$$

which coincides with the centre of the conic; and, if R be the radius, we have

$$\begin{aligned} R^2 &= \frac{(fh-bg)^2}{(ab-h^2)^2}+\frac{(hg-af)^2}{(ab-h^2)^2}-\frac{c(a+b)-(f^2+g^2)}{ab-h^2} \\ &= \frac{-(a+b)\ \Delta}{(ab-h^2)^2}, \end{aligned}$$

which shows that in rectangular axes the square of the radius of the director-circle is equal to the sum of the squares of the semi-axes of the conic given in equation (53).

That the same propositions hold for oblique coordinates may easily be shown, *viz.*, the equation of the tangents to the conic from (x', y') being

$$\begin{aligned} &(ax^2+2hxy+by^2+2gx+2fy+c)\times \\ &(ax'^2+2hx'y'+by'^2+2gx'+2fy'+c) \\ = &\left\{(ax'+hy'+g)x+(hx'+by'+f)y+gx'+fy'+c\right\}^2, \end{aligned}$$

the condition that these lines may include a right angle, gives for the locus of (x', y') the circle

$$\begin{aligned} &(ab-h^2)(x^2+y^2+2xy\cos\omega) \\ &+2\left\{(gb-fh)+(fa-gh)\cos\omega\right\}x \\ &+2\left\{(fa-gh)+(gb-fh)\cos\omega\right\}y \\ &+c(a+b)-(f^2+g^2)+2(fg-ch)\cos\omega=0 \end{aligned}$$

Comparing this with the standard form

$$(x-\alpha)^2+2(x-\alpha)(y-\beta)\cos\omega+(y-\beta)^2=r^2,$$

or

$$\begin{aligned} (x^2+y^2+2xy\cos\omega)-2(\alpha+\beta\cos\omega)x-2(\beta+\alpha\cos\omega)y& \\ +\alpha^2+\beta^2+2\alpha\beta\cos\omega-r^2=0&, \end{aligned}$$

we have at once

$$\alpha=\frac{fh-bg}{ab-h^2},\ \beta=\frac{hg-af}{ab-h^2},$$

which give the same coordinates of centre as before, while we have for the radius

$$\begin{aligned} r^2 &= \alpha^2+2\alpha\beta\cos\omega+\beta^2 \\ &\quad -\frac{c(a+b)-(f^2+g^2)+2(fg-ch)\cos\omega}{ab-h^2} \\ &= \Big[(fh-bg)^2+(hg-af)^2-(ab-h^2)\left\{c(a+b)-(f^2+g^2)\right\} \\ &\quad +2\left\{(fh-bg)(hg-af)-(fg-ch)(ab-h^2)\right\}\cos\omega\Big]\div(ab-h^2)^2 \end{aligned}$$

$$=\left[-(a+b)\,\Delta+2h\cos\omega.\ \Delta\right]\div(ab-h^2)^2$$

$$=\frac{-(a+b-2h\cos\omega)\,\Delta}{(ab-h^2)^2},$$

which, by a glance at (53), is seen to represent, as before, the sum of the squares of the semi-axes. From the value of the radius given above, it is clear that, when the conic is an equilateral hyberbola, the radius vanishes, and the director-circle is a circle of infinitesimal radius, *viz.*, it is the centre of the conic itself, and the asymptotes, therefore, are the only tangents of the equilateral hyperbola which are at right angles to each other.

§. 15. **Hyperbola referred to the asymptotes.**—In this section, we purpose to investigate what form the general equation assumes when the axes of coordinates are transformed to the asymptotes; two methods will be given, the first very direct and elementary, the second partly geometrical and requiring a knowledge of the invariants given above.

First method.

Let the general equation of the second degree be

$$ax^2+2hxy+by^2+2gx+2fy+c=0.$$

Transfer the coordinate axes to the centre of the conic, which is also the point of intersection of the asymptotes; the conic then becomes

$$ax^2+2hxy+by^2+\frac{\Delta}{ab-h^2}=0 \quad \ldots\ldots\ldots \ (61)$$

and the asymptotes are given by

$$ax^2+2hxy+by^2=0. \quad \ldots\ldots\ldots\ldots \ (62)$$

Now the equation of either asymptote may be taken to be $y=mx$, so that the two values of m are found, by substitution in (62), to be the roots of the quadratic

$$bm^2+2hm+a=0. \quad \ldots\ldots\ldots\ldots \ (63)$$

Hence, if α, β be the angles which the two asymptotes make with the axis of x, both $\tan\alpha$ and $\tan\beta$ must satisfy (63), so that we have

$$b\tan^2\alpha+2h\tan\alpha+a=0$$

or

$$b\sin^2\alpha+2h\sin\alpha\cos\alpha+a\cos^2\alpha=0 \quad \ldots\ldots \ (64)$$

and similarly,

$$b\sin^2\beta+2h\sin\beta\cos\beta+a\cos^2\beta=0 \quad \ldots\ldots\ldots\ldots \ (65)$$

Now, the angle between the original axes being $\omega=\frac{\pi}{2}$, the ordinary formulæ for the transformation of coordinates (Salmon's *Conics*, §. 9, Ed. 1879, p. 7) become in this case

$$y\sin\omega=X\sin\alpha+Y\sin\beta.$$
$$x\sin\omega=X\cos\alpha+Y\cos\beta.$$

Substituting these in (61), and arranging, we have for the equation of the conic

$$\begin{aligned}&(a\cos^2\alpha+2h\cos\alpha\sin\alpha+b\sin^2\alpha)X^2\\&+(a\cos^2\beta+2h\cos\beta\sin\beta+b\sin^2\beta)Y^2\\&+2\Big[a\cos\alpha\cos\beta+h\sin(\alpha+\beta)+b\sin\alpha\sin\beta\Big]XY\\&\qquad\qquad+\frac{\Delta}{ab-h^2}=0.\end{aligned}$$

But, by (64) and (65), the coefficients of X^2 and Y^2 vanish, and the equation becomes

$$2Hxy+\frac{\Delta}{ab-h^2}=0, \quad\ldots\ldots\ldots\ldots (66)$$

where H is the quantity to be calculated. For this purpose, we note that, if m_1, m_2 be the two roots of the quadratic in m given by (63), we have

$$m_1+m_2=-\frac{2h}{b},\quad m_1m_2=\frac{a}{b}.$$

Now, we see that

$$\begin{aligned}H&=\cos\alpha\cos\beta\Big\{a+h(\tan\alpha+\tan\beta)+b\tan\alpha\tan\beta\Big\}\\&=\frac{2(ab-h^2)}{b}\cos\alpha\cos\beta,\end{aligned}$$

where

$$\begin{aligned}\cos^2\alpha\cos^2\beta&=\Big\{(1+m_1^2)(1+m_2^2)\Big\}^{-1}\because m_1=\tan\alpha,\ m_2=\tan\beta.\\&=\Big[(m_1+m_2)^2+(1-m_1m_2)^2\Big]^{-1}\\&=\frac{b^2}{(a-b)^2+4h^2}.\end{aligned}$$

Therefore, $H=\pm\dfrac{2(ab-h^2)}{b}\cdot\dfrac{b}{\sqrt{\Big[(a-b)^2+4h^2\Big]}}$.

and, finally, the equation (66) becomes

$$xy=\pm\frac{\Delta}{4}\cdot\frac{\sqrt{\Big[(a-b)^2+4h^2\Big]}}{(ab-h^2)^2}, \quad\ldots\ldots (67)$$

which is, accordingly, the equation of the hyperbola referred to its asymptotes, which was sought.

Second method.

The same result may also be obtained as follows. The equation of the conic, referred to its centre, being, as before,

$$ax^2+2hxy+by^2+\frac{\Delta}{ab-h^2}=0, \quad\ldots\ldots\ldots\ldots (68)$$

and remembering that the absolute term is a rotation-invariant, we see that, when referred to the asymptotes, the equation must assume the form

$$Ax^2+2Hxy+By^2+\frac{\Delta}{ab-h^2}=0 \qquad \text{............ (69)}$$

Now, in this equation, the axis of x being an asymptote, one value of x must be infinite, and, therefore, in this equation, regarded as a quadratic in x, we must have $A=0$; similarly, the axis of y being the other asymptote, we must have $B=0$; so that (69) reduces to

$$2Hxy+\frac{\Delta}{ab-h^2}=0. \qquad \text{............ (70)}$$

To calculate H, we remark that, since the original axes are at right angles, we have $\omega=\frac{\pi}{2}$, and, as also $A=0$, $B=0$, the invariant relation

$$\frac{ab-h^2}{\sin^2\omega}=\frac{AB-H^2}{\sin^2\Omega}$$

reduces to

$$-H^2=(ab-h^2)\sin^2\Omega, \qquad \text{......... (71)}$$

where Ω is the angle between the asymptotes,

$$ax^2+2hxy+by^2=0. \qquad \text{............ (72)}$$

But, α, β being the angles which the asymptotes make with the axes, we have $\Omega=\alpha-\beta$, and, from equation (72),

$$\tan\Omega=\frac{2\sqrt{h^2-ab}}{a+b},$$

$$\sin\Omega=\frac{2\sqrt{h^2-ab}}{\sqrt{\{(a-b)^2+4h^2\}}},$$

so that (71) becomes

$$H^2=\frac{4(ab-h^2)^2}{(a-b)^2+4h^2},$$

and (70) gives for the required equation

$$xy=\pm\frac{\Delta}{4}\cdot\frac{\sqrt{\{(a-b)^2+4h^2\}}}{(ab-h^2)^2},$$

which is the same result as that obtained before. It may be noted that the value of H might have been obtained with equal ease by using the other invariant relation

$$\frac{a+b-2h\cos\omega}{\sin^2\omega}=\frac{A+B-2H\cos\Omega}{\sin^2\Omega}.$$

The geometrical meaning of this equation of the hyperbola is easily seen, *viz.*, taking ρ_1^2, ρ_2^2 for the squares of the semi-axes of the conic, and remembering that our original axes were rectangular, we have from (53),

$$\rho_1^2+\rho_2^2=\frac{-\Delta\,(a+b)}{(ab-h^2)^2}$$

$$\rho_1^2\,\rho_2^2=\frac{\Delta^2}{(ab-h^2)^3},$$

so that

$$(\rho_1^2-\rho_2^2)^2=(\rho_1^2+\rho_2^2)^2-4\,\rho_1^2\,\rho_2^2$$

$$=\frac{\Delta^2\left\{(a-b)^2+4h^2\right\}}{(ab-h^2)^4}.$$

The equation (67), therefore, may be written

$xy=\frac{1}{4}$ (Difference of squares of semi-axes),

which is a well-known result.

If the conic had been originally referred to axes inclined at an angle ω, the equation of the hyperbola referred to the asymptotes would have been

$$xy=\pm\frac{\Delta}{4\,(ab-h^2)^2}\left[(a-b)^2+4h^2-4\cos\omega\left\{h\,(a+b)-ab\cos\omega\right\}\right]^{\frac{1}{2}}$$

and the right hand side may be proved to be the difference of the squares of the semi-axes given by (53).

§§. 16—20. *Laplace's Linear Equation.*

§. 16. **Genesis of Laplace's Equation.**—The theorem that

$$\rho=\mathrm{A}x+\mathrm{B}y+\mathrm{C},$$

where ρ is the distance of any point on the curve from a fixed coplanar point, represents a conic is first due, substantially, to Laplace (*Mécanique Céleste*, Ed. 1878, t. I. p. 177). In integrating the equations for elliptic motion, he gets

$$dr=\lambda dx+\gamma dy,$$

which leads to

$$r=\frac{h^2}{\mu}+\lambda x+\gamma y;$$

Laplace then explicitly adds that "Cette équation, combinée avec celles-ci,

$$z=ax+by,\ r^2=x^2+y^2+z^2$$

donne une équation du second degré." It is proposed to examine here the geometrical meaning of the arbitrary constants in what I have called Laplace's Linear Equation to a conic.

§. 17. **Meaning of the Constants.**—That this equation represents a conic may be shewn in various ways, and some additional information regarding the constants may be gained from each standpoint of view. Thus, squaring the equation and putting

$$\rho^2=x^2+y^2,$$

we see that it is the equation to a conic which is an ellipse, a parabola, or an hyperbola according as

$$A^2+B^2 < = > 1.$$

Now, knowing that the curve is a conic, we may next compare its equation with the focal polar equation

$$l=\rho\,(1+e\cos\theta).$$

Remembering that ρ is a function of x and y, we conclude that the absolute terms in the two equations must be identical, whence

$$C=l=\text{semi-latus-rectum}.$$

Again, as the equation may be written in the form

$$\rho\div\left\{\frac{Ax+By+C}{\sqrt{A^2+B^2}}\right\}=\sqrt{A^2+B^2},$$

where ρ is the distance of any point on the curve from a fixed point, and

$$\frac{Ax+By+C}{\sqrt{A^2+B^2}}$$

is the perpendicular on the line $Ax+By+C=0$, we see, by attending to the focus-directrix method of generating conics, that the curve is a conic of which the directrix is

$$Ax+By+C=0,$$

and the eccentricity is given by

$$e^2=A^2+B^2.$$

§. 18. **Elliptic Motion.**—In order to represent these properties geometrically, and to shew their relation to elliptic motion, it is convenient to begin with the following method of integrating the equations of motion. We have, as usual,

$$\frac{d^2x}{dt^2}=-\frac{\mu x}{r^3},$$

$$\frac{d^2y}{dt^2}=-\frac{\mu y}{r^3},$$

$$x\frac{dy}{dt}-y\frac{dx}{dt}=h,$$

$$r^2\frac{d\theta}{dt}=h.$$

Now $$\frac{x}{r}=\cos\theta,\ \frac{y}{r}=\sin\theta;$$

therefore $$\frac{d}{dt}\left(\frac{x}{r}\right)=-\sin\theta.\frac{d\theta}{dt}=-\frac{y}{r^3}.\,h$$

whence $$\frac{y}{r^3}=-\frac{1}{h}\frac{d}{dt}\left(\frac{x}{r}\right),$$

and, similarly, $$\frac{x}{r^3}=\frac{1}{h}\frac{d}{dt}\left(\frac{y}{r}\right).$$

The equations of motion, therefore, become

$$\frac{d^2x}{dt^2} = -\frac{\mu}{h}\frac{d}{dt}\left(\frac{y}{r}\right),$$

$$\frac{d^2y}{dt^2} = \frac{\mu}{h}\frac{d}{dt}\left(\frac{x}{r}\right).$$

Integrating, we get

$$\frac{dx}{dt} = -\frac{\mu}{h}\left(\frac{y}{r} - \gamma\right),$$

$$\frac{dy}{dt} = \frac{\mu}{h}\left(\frac{x}{r} - \lambda\right),$$

and since

$$x\frac{dy}{dt} - y\frac{dx}{dt} = h,$$

we have

$$\frac{\mu x}{h}\left(\frac{x}{r} - \lambda\right) + \frac{\mu y}{h}\left(\frac{y}{r} - \gamma\right) = h,$$

which leads to

$$r = \frac{h^2}{\mu} + \lambda x + \gamma y,$$

which is Laplace's equation. Comparing this with the form

$$\rho = \text{A}x + \text{B}y + \text{C},$$

we find, as it ought to be,

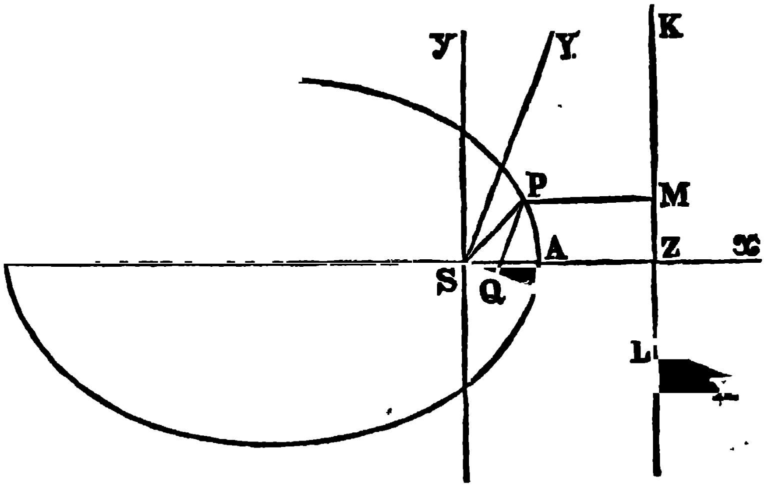
$$\text{C} = \frac{h^2}{\mu} = \text{semi-latus-rectum}.$$

This shews why, in integrating the equation

$$dr = \lambda dx + \gamma dy,$$

Laplace at once puts $\frac{h^2}{\mu}$ for the constant of integration.

§. 19. **Geometric interpretation.**—The subject may be made still clearer by the help of a diagram. The ellipse is originally referred to rectangular axes through the focus S; suppose that the coordinate axes revolve round the origin, making an angle XSx $(=\theta)$ with the former position. Then, we have



$$e \,.\, \text{PM} = \text{PS},$$

whence

$$\begin{aligned} e^2 \,.\, \text{PM}^2 = \text{PS}^2 &= \text{SQ}^2 + \text{QP}^2 \\ &= x^2 + y^2. \end{aligned}$$

But, as PM is parallel to SZ, we have

$$\text{PM} = p - x \cos\theta - y \sin\theta,$$

which gives

$$(ep - ex\cos\theta - ey\sin\theta)^2 = x^2 + y^2,$$

as might also have been obtained, but not so easily, by putting

$$\begin{aligned} x &= \text{X}\cos\theta + \text{Y}\sin\theta \\ y &= -\text{X}\sin\theta + \text{Y}\cos\theta \end{aligned}$$

in the equation

$$\frac{(x+ae)^2}{a^2} + \frac{y^2}{b^2} = 1.$$

Comparing this with the equation

$$(\text{C} + \text{A}x + \text{B}y)^2 = \rho^2 = x^2 + y^2,$$

we get

$$\text{C} = ep, \; \text{A} = -e\cos\theta, \; \text{B} = -e\sin\theta,$$

whence, as before,

$$e^2 = \text{A}^2 + \text{B}^2.$$

Also $\tan\theta = -\dfrac{\text{B}}{\text{A}}$,

and $p = \dfrac{\text{C}}{e} = \dfrac{\text{C}}{\sqrt{\text{A}^2 + \text{B}^2}}$.

Now, when $\theta = 0$, the new axis of X coincides with the major axis of the ellipse; but, when $\theta = 0$, we have also $\text{B} = 0$, by virtue of the relation

$$\tan\theta = -\frac{\text{B}}{\text{A}};$$

therefore

$$(\text{C} + \text{A}x)^2 = x^2 + y^2,$$

and, putting $x = 0$, this gives, as before,

$$y = \text{C} = \frac{h^2}{\mu}.$$

Again, the equation of the directrix is

$$x\cos\theta + y\sin\theta = p,$$

which, by substituting for θ and p, gives

$$\text{A}x + \text{B}y + \text{C} = 0,$$

and this agrees with our previous result.

It may be noticed that Gauss uses this form of the equation of a conic, and calls it the "*characteristic equation*" (*Theoria Motus*, §. 3). It is easy to see that when $\text{B} = 0$, we have $\text{A} = e$, and

$$\rho = C + ex,$$

which is the form finally adopted by Gauss. Since $x = \rho \cos \theta$, we have

$$\rho = \frac{C}{1 - e \cos \theta},$$

which is the ordinary polar equation. If $A = B = 0$, we have

$$\rho = \frac{h^2}{\mu},$$

which is the circle. The whole theory of lines of the second order may be based on the form

$$\rho = C + ex,$$

and, by means of this equation, Gauss has deduced the most complicated properties of elliptic motion with remarkable ease and elegance.

§. 20. **Eccentricity.**—If we square the equation

$$\rho = Ax + By + C,$$

and compare the result with the standard form

$$ax^2 + 2hxy + by^2 + 2gx + 2fy + c = 0,$$

we have, by equating coefficients,

$$\frac{a}{c} = \frac{A^2 - 1}{C^2}, \quad \frac{h}{c} = \frac{AB}{C^2}, \quad \frac{b}{c} = \frac{B^2 - 1}{C^2}.$$

Therefore

$$\frac{(a-b)^2 + 4h^2}{c^2} = \frac{(A^2 - B^2)^2}{C^4} + \frac{4A^2B^2}{C^4} = \frac{(A^2 + B^2)^2}{C^4} = \frac{e^4}{C^4},$$

and

$$\frac{ab - h^2}{c^2} = \frac{(A^2 - 1)(B^2 - 1) - A^2B^2}{C^4} = \frac{1 - e^2}{C^4},$$

which lead to

$$e^4 + \frac{(a-b)^2 + 4h^2}{ab - h^2}(e^2 - 1) = 0,$$

and this is the well-known equation for the eccentricity (§. 13).

The value of the eccentricity in oblique axes may also be obtained from Laplace's equation; for, if p be the perpendicular on the directrix from any point on the curve

$$\rho = Ax + By + C,$$

we have

$$\rho = ep,$$

and

$$p = \frac{(Ax + By + C) \sin \omega}{\sqrt{A^2 + B^2 - 2AB \cos \omega}},$$

whence

$$e^2 = \frac{A^2 + B^2 - 2AB \cos \omega}{\sin^2 \omega}. \qquad \text{............ (73)}$$

Now, squaring Laplace's equation, and substituting for ρ^2, remembering that in oblique axes

$$\rho^2 = x^2 + y^2 + 2xy \cos \omega,$$

we get

$$(A^2-1)\,x^2+2\,(AB-\cos\omega)\,xy+(B^2-1)\,y^2+2ACx+2BCy+C^2=0,$$

a comparison of which with the standard equation

$$ax^2+2hxy+by^2+2gx+2fy+c=0$$

gives

$$\frac{a}{c}=\frac{A^2-1}{C^2},\quad \frac{h}{c}=\frac{AB-\cos\omega}{C^2},\quad \frac{b}{c}=\frac{B^2-1}{C^2},$$

whence

$$\frac{a+b-2h\cos\omega}{c}=\frac{A^2+B^2-2AB\cos\omega-2\sin^2\omega}{C^2}$$

$$=\frac{(e^2-2)\sin^2\omega}{C^2},$$

and

$$\frac{ab-h^2}{c^2}=\frac{\sin^2\omega-(A^2+B^2-2AB\cos\omega)}{C^4}.$$

$$=\frac{(1-e^2)\sin^2\omega}{C^4},$$

by substitution from the value of e^2 in (73). These lead to the familiar result

$$\frac{(e^2-2)^2}{1-e^2}=\frac{(a+b-2h\cos\omega)^2}{(ab-h^2)\sin^2\omega}.$$

§. 21. *Area of a triangle.*

§. 21. **Triangle formed by two tangents.**—We now proceed to investigate the area of the triangle formed by two tangents drawn from any point to the general conic, and the chord of contact. For this purpose, we will first confine our attention to the simple case when the tangents are drawn from the origin, and then an easy application of invariants will smoothly lead to the solution of the general problem.

The tangents which can be drawn from the origin to the conic

$$S\equiv ax^2+2hxy+by^2+2gx+2fy+c=0$$

are given by (Salmon's *Conics*, §. 147, Ed. 1879, p. 149)

$$(ac-g^2)\,x^2+2\,(ch-gf)\,xy+(bc-f^2)\,y^2=0,\quad\ldots\ (74)$$

and the chord of contact being the polar of the origin is

$$gx+fy+c=0.\quad\ldots\ldots\ldots\ldots\ (75)$$

The area of the triangle formed by the intersection of the lines in (74) and (75) is at once written down by substitution in (31), *viz.*,

$$(\text{Area})^2=-\frac{c^3\,(af^2+bg^2+ch^2-2fgh-abc)}{af^2-2fgh+bg^2},$$

which may be written

$$\text{Area}=\frac{c\sqrt{-c\,\Delta}}{\left\{(ab-h^2)\,c-\Delta\right\}}\quad\ldots\ldots\ldots\ (76)$$

Now, if the tangents are drawn from any point (x', y') to the conic S, we may make that point our new origin, and by this transformation we know that c is changed into the point-function S′, while Δ and $(ab-h^2)$, being translation-invariants, remain unaltered by the transformation; hence, as a generalization of (76), we are able to enunciate the following general

Theorem.—If from any point (x', y'), tangents are drawn to the conic

$$ax^2+2hxy+by^2+2gx+2fy+c=0$$

the area of the triangle formed by the two tangents with their chord of contact is

$$\frac{S'\sqrt{-\Delta S'}}{(ab-h^2)S'-\Delta}, \qquad \text{............} \quad (77)$$

where Δ is the discriminant and S′ the point-function of the conic.

A variety of particular theorems may be deduced from this general formula; thus, if the curve is a parabola, the area in question is

$$S'\sqrt{-\frac{S'}{\Delta}};$$

and, if, further, the point from which the tangents are drawn be the origin, we have the theorem that, if the general equation of the second degree represents a parabola, and two tangents be drawn from the origin to the curve, the area of the triangle formed by the two tangents and the chord of contact is

$$\frac{c\sqrt{c}}{f\sqrt{a}-g\sqrt{b}}.$$

Again, the chord of contact being the polar of (x', y') with respect to the conic, has for its equation

$$(ax'+hy'+g)\,x+(hx'+by'+f)\,y+gx'+fy'+c=0,$$

and, therefore, if p be the perpendicular let fall on this chord from (x', y'), we have easily

$$p^2=\frac{S'^2}{(ax'+hy'+g)^2+(hx'+by'+f)^2} \qquad \text{......} \quad (78)$$

But, if $D\equiv 0$ be the equation of the director-circle of the conic, and, therefore, D' its point-function, we have from (60)

$$(ax'+hy'+g)^2+(hx'+by'+f)^2=(a+b)\,S'-D'.$$

Hence (78) gives

$$p^2=\frac{S'^2}{(a+b)\,S'-D'}. \qquad \text{............} \quad (79).$$

It is now easy to find the length of the chord intercepted between the points of contact of the tangents, for if λ be the length sought, we have

$$\lambda = \frac{2(\text{Area of triangle})}{p},$$

which, by the help of equation (77), reduces to

$$\lambda = \frac{2\sqrt{\{\Delta\, S'\, D' - (a+b)\,\Delta\, S'^2\}}}{(ab-h^2)\, S' - \Delta}.$$

Hence, we have the

Theorem.—If from any point (x', y') two tangents be drawn to a conic given by the general equation, the length of the chord of contact is

$$\frac{2\sqrt{\{\Delta\, S'\, D' - (a+b)\,\Delta\, S'^2\}}}{(ab-h^2)\, S' - \Delta}, \qquad \ldots\ldots (80)$$

where S′, D′ are the point-functions of the conic and of its director-circle, respectively.

Various particular cases may be deduced from the general formula in (80). Thus, if the tangents be drawn from any point on the director-circle, that is, if the tangents be orthogonal, the length of the chord of contact is

$$\frac{2S'\sqrt{-(a+b)\,\Delta}}{(ab-h^2)\, S' - \Delta}.$$

Again, if two tangents be drawn from the directrix of a parabola to the curve, the length of the chord is

$$2S'\sqrt{-\frac{a+b}{\Delta}} = 2S'.\frac{\sqrt{a+b}}{f\sqrt{a} - g\sqrt{b}}.$$

If the curve is an equilateral hyperbola, the director-circle degenerates into the centre of the conic, and the chord in question, being the line at infinity, is of infinite length; this also follows from (80), for in this case

$$D' = 0,\ S' = \frac{\Delta}{ab-h^2},\ a+b=0,$$

so that the numerator becomes the square root of a zero-quantity, while the denominator also vanishes, and, therefore, the limiting value of the apparently indeterminate expression is really infinite.

Again, we can easily find the area of the triangle formed by the chord of contact with the lines joining the centre to the points of contact. For the chord of contact, being the polar of (x', y'), is

$$(ax'+hy'+g)x + (hx'+by'+f)y + gx'+fy'+c = 0, \quad \ldots (81)$$

and the centre being

$$\left(\frac{hf-bg}{ab-h^2}, \frac{hg-af}{ab-h^2}\right),$$

the perpendicular from the centre on the line in (81) is given by

$$\left\{(ax'+hy'+g)(hf-bg)+(hx'+by'+f)(hg-af)+(gx'+fy'+c)(ab-h^2)\right\}$$
$$\div (ab-h^2)\left\{(ax'+hy'+g)^2+(hx'+by'+f)^2\right\}^{\frac{1}{2}}.$$

If, therefore, p_1 be the length of the perpendicular in question, this reduces to

$$p_1 = \frac{\Delta}{(ab-h^2)\sqrt{\left\{(a+b)S'-D'\right\}}} \quad \ldots\ldots \quad (82)$$

Hence, as the length of the chord is given in (80), the area of the triangle is written down to be

$$\tfrac{1}{2}p_1\,\lambda = \frac{\Delta\sqrt{-\Delta S'}}{(ab-h^2)\left\{(ab-h^2)S'-\Delta\right\}} \quad \ldots\ldots\ldots \quad (83)$$

It must be carefully noticed that the two triangles whose areas are given in (77) and (83), being on opposite sides of the chord of contact, are affected with opposite signs; hence their algebraic sum establishes the truth of a property enunciated by Prof. Nash, *viz.*, we have the following

Theorem.—If two tangents are drawn from any point (x', y') to the conic

$$ax^2+2hxy+by^2+2gx+2fy+c=0,$$

the area of the quadrilateral formed by the two tangents and the two lines joining the centre to the points of contact is

$$\frac{\sqrt{-\Delta S'}}{ab-h^2}, \quad \ldots\ldots\ldots\ldots \quad (84)$$

where S' is the point-function of the conic.

It is easy to remark that the geometrical meaning of the equation of the conic is that, when the area of the quadrilateral vanishes, the locus of the point must be the curve itself. Again, since we know from geometry that the area of the quadrilateral is real or imaginary according as the point is outside or inside the curve, we infer from (84) that any given point is inside or outside the curve according as $\Delta S'$ is positive or negative, which is equivalent to the statement that the point is inside or outside according as the discriminant and the point-function have the same or different signs, and the same result, of course, also follows from the formula in (77). Here we may add that if from any point two tangents be drawn to a conic, the angle between the two tangents will be real, only if a certain relation holds amongst the coefficients in the equation of the conic; thus, first taking the simple case when the tangents are drawn from the origin, we have the tangents given by equation (74), *viz.*

$$(ac-g^2)x^2+2(ch-fg)xy+(bc-f^2)y^2=0,$$

and clearly the angle between these two lines will be real, if

$$(ch-fg)^2 > (ac-g^2)(bc-f^2)$$

or

$$\Delta < 0.$$

Hence, remembering that the discriminant is a translation-invariant, we can at once generalize the theorem to the case where the tangents are drawn from any point, *viz.*, the angle between the tangents is real, if the discriminant is negative; but we have shewn that, if the tangents are real and the point outside the curve, the discriminant and the point-function must have different signs, so that, as the discriminant is negative, the point-function must be positive; hence, finally, we have the very simple

Theorem.—Any point is outside a conic, on the curve, or inside it, according as the point-function is positive, zero, or negative.

§§. 22—23. *Inclinations of tangents to conics.*

§. 22. **Theorem.**—We shall now prove a theorem which shows how some well-known properties of the circle and the ellipse are correlated.

Consider the conic

$$\frac{x^2}{a^2}+\frac{y^2}{b^2}=1 \qquad \ldots\ldots\ldots\ldots (85)$$

where b^2 is essentially indeterminate in sign and value. The tangents at any two points (x_1, y_1), (x_2, y_2) are

$$\frac{xx_1}{a^2}+\frac{yy_1}{b^2}=1 \qquad \ldots\ldots\ldots\ldots (86)$$

$$\frac{xx_2}{a^2}+\frac{yy_2}{b^2}=1, \qquad \ldots\ldots\ldots\ldots (87)$$

and their chord of contact is

$$\frac{x\,(x_1+x_2)}{a^2}+\frac{y(y_1+y_2)}{b^2}=\frac{x_1x_2}{a^2}+\frac{y_1y_2}{b^2}+1 \qquad \ldots\ldots\ldots (88)$$

Hence, if θ, ϕ, ψ be the angles of inclination of the two tangents and of their chord of contact to a directrix, we have

$$\tan\theta=-\frac{a^2}{b^2}\cdot\frac{y_1}{x_1} \qquad \ldots\ldots\ldots\ldots (89)$$

$$\tan\phi=-\frac{a^2}{b^2}\cdot\frac{y_2}{x_2} \qquad \ldots\ldots\ldots\ldots (90)$$

$$\tan\psi=-\frac{a^2}{b^2}\cdot\frac{y_1+y_2}{x_1+x_2} \qquad \ldots\ldots\ldots\ldots (91)$$

Substituting for y_1, y_2 from (89) and (90) in

$$\frac{x_1^2}{a^2}+\frac{y_1^2}{b^2}=1,\quad \frac{x_2^2}{a^2}+\frac{y_2^2}{b^2}=1,$$

we have

$$x_1=\frac{a^2}{\sqrt{a^2+b^2\tan^2\theta}},\quad x_2=\frac{a^2}{\sqrt{a^2+b^2\tan^2\phi}} \qquad \ldots\ldots (92), (93)$$

But, substituting for y_1, y_2 from (89) and (90) in (91), we have

$$\tan\psi = \frac{x_1 \tan\theta + x_2 \tan\phi}{x_1 + x_2} \qquad \ldots\ldots\ldots\ldots (94)$$

Now, assume

$$a^2 + b^2 \tan^2\theta = \frac{a^2\lambda^2}{\cos^2\theta},$$

$$a^2 + b^2 \tan^2\phi = \frac{a^2\mu^2}{\cos^2\phi},$$

so that

$$\lambda^2 = 1 - e^2 \sin^2\theta,\ \mu^2 = 1 - e^2 \sin^2\phi,$$

and
$$x_1 = \frac{a\cos\theta}{\lambda},\ x_2 = \frac{a\cos\phi}{\mu}.$$

Substituting these values in (94), we arrive at the following symmetrical theorem, *viz.*, if θ, ϕ, ψ be the angles of inclination of any two tangents to a conic and of their chord of contact to a directrix, we have

$$\tan\psi = \frac{\lambda^{-1}\sin\theta + \mu^{-1}\sin\phi}{\lambda^{-1}\cos\theta + \mu^{-1}\cos\phi},$$

where the eccentricity of the conic is given by

$$e^2 = \frac{1-\lambda^2}{\sin^2\theta} = \frac{1-\mu^2}{\sin^2\phi}.$$

(See *Educational Times*, November 1885, my Ques. 8337).

§. 23. **Applications.**—To verify the truth of this theorem, we proceed to some applications. In the parabola, $e = 1$, so that

$$\lambda = \cos\theta,\ \mu = \cos\phi,$$

which give

$$2\tan\psi = \tan\theta + \tan\phi,$$

a result which can be proved independently, and is often useful in the elementary theory of projectiles. The particular case of the circle is specially interesting. Here $e = 0$, and $\lambda = \mu = 1$, whence

$$\tan\psi = \frac{\sin\theta + \sin\phi}{\cos\theta + \cos\phi} = \tan\frac{\theta+\phi}{2},$$

and
$$2\psi = \theta + \phi,$$
$$\text{or}\quad \psi - \theta = \phi - \psi.$$

To see the geometric meaning of this analytic condition, observe that, in the circle, the foci coincide with the centre, and the position of the axes becomes essentially indeterminate, while the directrix is situated at an infinite distance. Now draw any two tangents OA, OB to a circle, and let OA, OB, BA intersect the line at infinity in the points C, D, E; $\angle OCD = \theta$, $\angle ODC = -\phi$, $\angle BEC = \psi$, ϕ being taken negative as it is measured in a direction opposite to that in which θ, ψ are measured;

hence we have

$$\angle \mathrm{OAB} = \angle \mathrm{CAE} = \theta - \psi$$
$$\angle \mathrm{OBA} = \psi - \phi.$$

Therefore $\angle \mathrm{OAB} = \angle \mathrm{OBA}$, and $\mathrm{OA} = \mathrm{OB}$, just as it should be, so that the geometric meaning is the equality of two tangents to a circle drawn from any external point. Lastly, if we draw any two tangents OA, OB to any conic, and, if OA, OB, BA intersect a directrix at C, D, E, we have as before

$$\angle \mathrm{OAB} = \theta - \psi, \ \angle \mathrm{OBA} = \psi - \phi.$$

Now draw through the centre two radii-vectores of the curve (ρ_1, ρ_2), making angles θ, ϕ with the conjugate axis; then, from the polar equation to the curve, we have

$$\rho_1^2 = \frac{b^2}{1 - e^2 \sin^2\theta}, \ \rho_2^2 = \frac{b^2}{1 - e^2 \sin^2\phi},$$

so that

$$\rho_1 = \frac{b}{\lambda}, \ \rho_2 = \frac{b}{\mu},$$

which furnish the geometrical meanings of the symbols λ, μ in the statement of the theorem. Substituting for λ, μ in our original equation, we have

$$\tan\psi = \frac{\rho_1 \sin\theta + \rho_2 \sin\phi}{\rho_1 \cos\theta + \rho_2 \cos\phi},$$

whence

$$\frac{\rho_1}{\rho_2} = \frac{\sin(\psi - \phi)}{\sin(\theta - \psi)} = \frac{\mathrm{OA}}{\mathrm{OB}},$$

and this asserts that the tangents OA, OB are proportional to the central radii-vectores which are obviously parallel to them. In the case of the circle, the indeterminateness in the position of the axes makes all the radii-vectores equal, so that, as shewn before,

$$\mathrm{OA} = \mathrm{OB}, \ \ \psi - \phi = \theta - \psi.$$

It may be remarked that we might have started from the polar instead of the Cartesian equations, as just shewn, and thus worked up to the value of $\tan\psi$ given above; it is also useful to notice that, though the theorem was obtained from a very particular form of the equation of a central conic, it is perfectly true for the general conic, inasmuch as the eccentricity only appears in the final result.

§. 24. *Similar Conics.*

§. 24. **Generation of Similar Conics.** Given any conic, any other conic which is concentric with it, and similar and similarly situated, may be generated as the locus of a point through which any two chords of the conic being drawn at right angles to each other, the sum of the reciprocals of the rectangles under the segments of each chord is constant, the variation of this constant furnishing the different members of the family of similar conics.

Let

$$ax^2+2hxy+by^2+2gx+2fy+c=0 \quad \ldots\ldots\ldots\ldots \quad (95)$$

be the primitive conic, and (x', y') the point through which the chords are drawn at right angles to each other and whose locus we seek. Transferring the origin to this point, the conic becomes

$$ax^2+2hxy+by^2+2g'x+2f'y+c'=0 \quad \ldots\ldots\ldots\ldots \quad (96)$$

where c' is the point-function. The polar form of this equation is

$$(a\cos^2\theta+2h\cos\theta\sin\theta+b\sin^2\theta)\,\rho^2+2(g'\cos\theta+f'\sin\theta)\,\rho+c'=0 \quad \ldots \quad (97)$$

Hence, if ρ_1, ρ_2 be the segments of the chord drawn through the new origin, inclined at an angle θ to the axis of x, and ρ_3, ρ_4 the segments of the chord at right angles, we have, from (97),

$$\rho_1\rho_2=\frac{c'}{a\cos^2\theta+2h\cos\theta\sin\theta+b\sin^2\theta},$$

$$\rho_3\rho_4=\frac{c'}{a\sin^2\theta-2h\sin\theta\cos\theta+b\cos^2\theta}$$

so that

$$\frac{1}{\rho_1\rho_2}+\frac{1}{\rho_3\rho_4}=\frac{a+b}{c'},$$

which shews that the sum of the reciprocals of the rectangles is independent of the direction of the chord, and for any given value of this sum, say $\frac{1}{k^2}$, the locus of (x', y') is given by

$$\frac{a+b}{c'}=\frac{1}{k^2},$$

which may be written

$$ax^2+2hxy+by^2+2gx+2fy+c=k^2\,(a+b) \quad \ldots\ldots\ldots\ldots \quad (98)$$

and this, of course, represents a conic concentric with the primitive one given by (95), and similar and similarly situated; and we get a family of similar conics by assigning all possible values to k. It is interesting to remark that the property established here is general in a twofold sense, *viz.*, if the sum of the reciprocals of the rectangles under the segments is to be constant, the point may be any point on the conic given by (98), and the chords may be inclined at any angle to the axis of x, provided they include a right angle. The same results, of course, could have been obtained by applying the process to each of the conics separately, *viz.*, if we have the central conic

$$\frac{x^2}{a^2}+\frac{y^2}{b^2}=1,$$

the value of

$$\frac{1}{\rho_1\,\rho_2}+\frac{1}{\rho_3\,\rho_4}$$

is found to be

$$\frac{\dfrac{1}{a^2}+\dfrac{1}{b^2}}{\dfrac{x'^2}{a^2}+\dfrac{y'^2}{b^2}-1},$$

and the locus in question is

$$\frac{x^2}{a^2}+\frac{y^2}{b^2}=k^2\left(\frac{1}{a^2}+\frac{1}{b^2}+\frac{1}{k^2}\right).$$

Similarly, if we have the parabola

$$y^2=4ax,$$

the value of

$$\frac{1}{\rho_1\,\rho_2}+\frac{1}{\rho_3\,\rho_4}$$

is

$$\frac{1}{y'^2-4ax'},$$

and the locus sought is

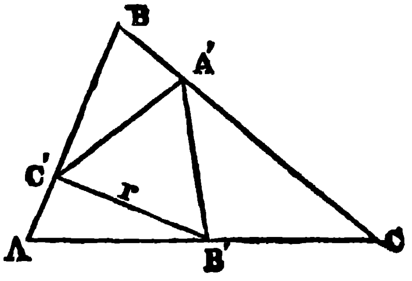
$$y^2-4ax=k^2.$$

Lastly, as in the equilateral hyperbola, we have $(a+b)=0$, the required conic-locus is the given conic itself, and we have the following

Theorem.—If through a given point P in the plane of any conic, any two chords be drawn mutually at right angles, the sum of the reciprocals of the rectangles under the segments is constant; and, for different values of this constant, the locus of P is a family of concentric, similar and similarly situated conics, which, however, all merge into the primitive conic when it is an equilateral hyperbola. (Cf. Salmon's *Conics*, §. 181, Ex. 2, Ed. 1879, p. 175).

§. 25. *Theory of Envelopes.*

§. 25. **On Three Parabolic Envelopes.**—As an illustration of the theory of envelopes, we proceed to discuss the envelopes of the sides of all equilateral triangles inscribed in a given triangle.



Let ABC be the given triangle, and A'B'C' an equilateral triangle inscribed in it; let r be the side of this equilateral triangle, and let $\angle \text{AC}'\text{B}'=\frac{\pi}{3}+\theta$, so that $\angle \text{A}'\text{C}'\text{B}=\frac{\pi}{3}-\theta$, $\angle \text{BA}'\text{C}'=\frac{2\pi}{3}+\theta-\text{B}$,

$\angle AB'C' = \frac{2\pi}{3} - \theta - A$. Then, in order to find the envelope of B′C′, take AC, AB as the axes of x and y respectively, so that the equation of B′C′ is

$$\frac{x}{AB'} + \frac{y}{AC'} = 1 \qquad \text{............ (99)}$$

Now, we have from the geometry of the figure

$$AC' = \frac{r}{\sin A} \sin\left(\frac{2\pi}{3} - \theta - A\right), \qquad \text{............ (100)}$$

$$AB' = \frac{r}{\sin A} \sin\left(\frac{\pi}{3} + \theta\right), \qquad \text{............ (101)}$$

while

$$c = AB = AC' + C'B$$

gives

$$\frac{c}{r} = \frac{\sin\left(\frac{2\pi}{3} - \theta - A\right)}{\sin A} + \frac{\sin\left(\frac{2\pi}{3} + \theta - B\right)}{\sin B}$$

$$= \left\{\frac{\sin\left(\frac{2\pi}{3} - A\right)}{\sin A} + \frac{\sin\left(\frac{2\pi}{3} - B\right)}{\sin B}\right\} \cos\theta$$

$$+ \left\{\frac{\cos\left(\frac{2\pi}{3} - B\right)}{\sin B} - \frac{\cos\left(\frac{2\pi}{3} - A\right)}{\sin A}\right\} \sin\theta,$$

which may be written in the form

$$\frac{c}{r} = P\cos\theta + Q\sin\theta, \qquad \text{............ (102)}$$

where

$$P = 1 + \frac{\sqrt{3}}{2}(\cot A + \cot B) \qquad \text{............ (103)}$$

$$Q = \tfrac{1}{2}(\cot A - \cot B) \qquad \text{............ (104)}$$

The equation of B′C′ in (99), therefore, reduces to

$$\frac{\sin A}{\sin\left(\frac{\pi}{3} + \theta\right)}\, x + \frac{\sin A}{\sin\left(\frac{2\pi}{3} - \theta - A\right)}\, y = r,$$

which may be written

$$\left\{x \sin\left(\frac{2\pi}{3} - A\right) + y \sin\frac{\pi}{3}\right\} \cos\theta + \left\{y \cos\frac{\pi}{3} - x\cos\left(\frac{2\pi}{3} - A\right)\right\} \sin\theta$$

$$= \frac{r}{\sin A} \cdot \sin\left(\frac{\pi}{3} + \theta\right) \sin\left(\frac{2\pi}{3} - \theta - A\right)$$

$$= \frac{r}{2\sin A}\left\{\cos\left(\frac{\pi}{3} - 2\theta - A\right) + \cos A\right\},$$

and this may be written

$$r\left\{\cos A+\cos\left(\frac{\pi}{3}-A-2\theta\right)\right\}=E\cos\theta+F\sin\theta, \quad \ldots \quad (105)$$

where

$$E=2\sin A\left\{x\sin\left(\frac{2\pi}{3}-A\right)+y\sin\frac{\pi}{3}\right\} \quad \ldots\ldots\ldots\ldots \quad (106)$$

$$F=2\sin A\left\{y\cos\frac{\pi}{3}-x\cos\left(\frac{2\pi}{3}-A\right)\right\} \quad \ldots\ldots\ldots\ldots \quad (107)$$

Eliminating r between (102) and (105), we have

$$2c\left\{\cos A+\cos\left(\frac{\pi}{3}-A-2\theta\right)\right\}$$

$$=PE.\ 2\cos^2\theta+QF.\ 2\sin^2\theta+(QE+PF).\ 2\sin\theta\cos\theta.$$

Assuming, therefore, $2\theta=\phi$, this may be written

$$2c\cos A+2c\cos\left(\frac{\pi}{3}-A-\phi\right)$$

$$=PE+QF+(PE-QF)\cos\phi+(QE+PF)\sin\phi$$

Expanding $\cos\left(\frac{\pi}{3}-A-\phi\right)$, and arranging the coefficients of $\sin\phi$ and $\cos\phi$, this may be written

$$M\sin\phi+N\cos\phi=K \quad \ldots\ldots\ldots\ldots \quad (108)$$

where

$$M=QE+PF-2c\sin\left(\frac{\pi}{3}-A\right) \quad \ldots\ldots\ldots\ldots \quad (109)$$

$$N=PE-QF-2c\cos\left(\frac{\pi}{3}-A\right) \quad \ldots\ldots\ldots\ldots \quad (110)$$

$$K=2c\cos A-PE-QF \quad \ldots\ldots\ldots\ldots \quad (111)$$

The envelope of (108) is obviously

$$M^2+N^2=K^2,$$

and this, being written in the form

$$M^2=(K+N)(K-N),$$

leads, on substitution from (109), (110), and (111), to the equation

$$(QE+PF)^2-4c\sin\left(\frac{\pi}{3}-A\right).\ (QE+PF)+4c^2\sin^2\left(\frac{\pi}{3}-A\right)$$

$$=4c^2\left\{\cos^2A-\cos^2\left(\frac{\pi}{3}-A\right)\right\}$$

$$-4c\left\{\left[\cos A-\cos\left(\frac{\pi}{3}-A\right)\right]PE+\left[\cos A+\cos\left(\frac{\pi}{3}-A\right)\right]QF\right\}$$

$$+4\ PQEF,$$

which may be written

$$(QE-PF)^2-4c\left[Q.\sin\left(\frac{\pi}{3}-A\right)+P\left\{\cos\left(\frac{\pi}{3}-A\right)-\cos A\right\}\right]E$$
$$-4c\left[P\sin\left(\frac{\pi}{3}-A\right)-Q\left\{\cos\left(\frac{\pi}{3}-A\right)+\cos A\right\}\right]F+4c^2\sin^2 A=0.$$

As E and F are linear functions of x and y, while P and Q are constant quantities, it is clear that this equation of the required envelope represents a parabola, and a diameter of this parabolic envelope is given by

$$QE=PF,$$

which is equivalent to

$$\left\{P.\cos\left(\frac{2\pi}{3}-A\right)+Q\sin\left(\frac{2\pi}{3}-A\right)\right\}x-\left\{P\cos\frac{\pi}{3}-Q\sin\frac{\pi}{3}\right\}y=0,$$

or, since

$$P\cos\left(\frac{2\pi}{3}-A\right)+Q\sin\left(\frac{2\pi}{3}-A\right)=\frac{\sin\left(\frac{\pi}{3}+C\right)}{\sin B}$$

and

$$P\cos\frac{\pi}{3}-Q\sin\frac{\pi}{3}=\frac{\sin\left(\frac{\pi}{3}+B\right)}{\sin B},$$

the equation of the diameter may be written

$$x\sin\left(\frac{\pi}{3}+C\right)-y\sin\left(\frac{\pi}{3}+B\right)=0.$$

The diameter can be geometrically constructed as follows, *viz.*, on BC describe externally an equilateral triangle BDC, and join AD; then AD is the diameter; for, if the point D be (x, y), we have

$$\frac{DC}{y}=\frac{\sin A}{\sin\left(\frac{\pi}{3}+C\right)},\quad \frac{DB}{x}=\frac{\sin A}{\sin\left(\frac{\pi}{3}+B\right)},$$

so that the equation of AD is

$$x\sin\left(\frac{\pi}{3}+C\right)=y\sin\left(\frac{\pi}{3}+B\right),$$

which is also the equation of the diameter.

Again, if we consider the envelopes of the other two sides, they also will be parabolas, and their diameters will be obtained by joining B and C to the remote vertices E and F of the equilateral triangles described externally on the opposite sides; and, since, from elementary geometry, AD, BE, CF intersect in a point, it can easily be shewn, from Euc. III. 22, that the acute angle between any two of them is $\frac{\pi}{3}$. Thus, finally, we have the

Theorems.—The envelopes of the sides of the equilateral triangles which can be inscribed in any given triangle ABC, are three parabolas;

the acute angle between every pair of the three axes is $\frac{\pi}{3}$; if, through the vertices of the given triangle, diameters of the parabolas be drawn, they intersect in a fixed point which may be determined geometrically, *viz.*, if equilateral triangles BDC, CEA, AFB be described externally on the sides, the lines AD, BE, CF are diameters of the enveloping parabolas and meet in a point, the acute angle between each pair being $\frac{\pi}{3}$.

§§. 26—27. *Reciprocal Polars.*

§. 26. **Reciprocal of Central Conic.**—It is well-known that the first focal pedal of a conic, being the locus of the foot of the perpendicular dropped from a focus on any tangent, is, in the case of central conics, the circle described on the axis-major as diameter; hence, as the reciprocal of any curve is the inverse of its pedal, it is clear that the inverse of pedal of the first focal pedal of any central conic is the reciprocal polar of a circle, which reciprocal is known to be a conic; hence it follows that the second pedal of a conic with respect to a focus is the inverse of a conic whose position and magnitude may be determined geometrically. For we know that the reciprocal of a circle of radius a, with respect to a circle of radius k, is a conic which is an ellipse if the origin of reciprocation lies within the given circle, the focus of the conic is at the origin of reciprocation, the semi-latus-rectum is $\frac{k^2}{a}$, the eccentricity is $\frac{c}{a}$, where c is the distance between the centres of the given circle and the circle of reciprocation, and the directrix is a line at right angles to the central line drawn at a distance $\frac{k^2}{c}$ from the origin of reciprocation. Now, in the question under consideration, we have to find the reciprocal of the circle described on the major axis as diameter, with a focus as origin of reciprocation; hence the conic is an ellipse, a focus of which is the focus of the given conic, the semi-latus-rectum is $\frac{k^2}{a}$, the eccentricity is equal to the eccentricity of the given conic, and the directrix is a line at right angles to the axis-major of the given conic, at a distance $\frac{k^2}{ae}$ from the given focus.

These results are easily verified analytically, for the given conic being

$$\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1,$$

remove the origin to the focus, say the negative one; then the conic is

$$\frac{(x-ae)^2}{a^2}+\frac{y^2}{b^2}=1,$$

and the first pedal, being the circle on the major axis as diameter, is

$$(x-ae)^2+y^2=a^2,$$

the coordinates of any point on which may be expressed by means of a single parameter, *viz.*,

$$x=a\ (e+\cos\phi),$$
$$y=a\sin\phi,$$

and hence the equation of any tangent may be thrown into the form

$$(x-ae)\cos\phi+y\sin\phi=a.$$

A line at right-angles to this through the origin (which is now the focus) is

$$x\sin\phi-y\cos\phi=0,$$

and, as the second pedal of the conic, or the first pedal of the circle, is the locus of the intersection of the two lines, we have, by solving for $\sin\phi$ and $\cos\phi$,

$$\sin\phi=\frac{ay}{x^2+y^2-aex},\ \cos\phi=\frac{ax}{x^2+y^2-aex},$$

where (x, y) is, of course, a point on the pedal, *viz.*, the actual equation is

$$a^2\ (x^2+y^2)=(x^2+y^2-aex)^2,$$

which quartic, therefore, is the second pedal of the given conic with respect to a focus. To see that this is the inverse of a conic, we have only to take its inverse, *viz.*, substituting for x and y

$$\frac{k^2x}{x^2+y^2},\ \frac{k^2y}{x^2+y^2}$$

respectively, the second-pedal-quartic is seen to be the inverse of

$$a^2\ (x^2+y^2)=(k^2-aex)^2,$$

which is, of course, a conic, *viz.*, this may be written

$$\frac{x^2}{a^2}+\frac{y^2}{b^2}=\frac{k^4}{a^2b^2}-\frac{2k^2ex}{ab^2}$$

which is equivalent to

$$\left(\frac{x}{a}-\frac{k^2e}{b^2}\right)^2+\frac{y^2}{b^2}=\frac{k^4}{b^4}.$$

It may be noted that any two conics having a common focus have two of their common chords passing through the intersection of their directrices; in the present case, therefore, two of the chords of intersection of this conic and the given conic are parallel to the directrices; one of these chords is found, by subtracting the equations of the conics, to be the line

$$x=\frac{k^2-b^2}{2ae}.$$

§. 27. **Reciprocal of Evolute of Conic.***—We now purpose to investigate the reciprocal polars of evolutes of conics; but as all central conics are included in the equation

$$\left(\frac{x}{a}\right)^m + \left(\frac{y}{b}\right)^m = 1, \qquad \ldots\ldots\ldots\ldots (112)$$

we will discuss the problem with regard to this general case. Since the reciprocal is the inverse of the pedal, and as the pedal of the evolute is the locus of the intersection of the normal and the line drawn at right angles to it through the origin, it is clear that the reciprocal polar of the evolute is the inverse of the locus of the point of intersection of the normal at any point of the curve, and the right line dropped perpendicular to it from the origin. Now, the normal at any point (x, y) of the curve in (112) is

$$\frac{m}{a}\left(\frac{x}{a}\right)^{m-1}(\mathrm{Y}-y) = \frac{m}{b}\left(\frac{y}{b}\right)^{m-1}(\mathrm{X}-x),$$

where X, Y being the current coordinates, the equation may be written

$$\frac{x^{m-1}}{a^m}\mathrm{Y} - \frac{y^{m-1}}{b^m}\mathrm{X} = xy\left(\frac{x^{m-2}}{a^m} - \frac{y^{m-2}}{b^m}\right). \qquad \ldots\ldots\ldots (113)$$

The straight line through the origin at right angles to this, is

$$\frac{y^{m-1}}{b^m}\mathrm{Y} + \frac{x^{m-1}}{a^m}\mathrm{X} = 0 \qquad \ldots\ldots\ldots\ldots (114)$$

At the common point of intersection of the two lines given by (113) and (114), we have

$$\left\{\frac{x^{2(m-1)}}{a^{2m}} + \frac{y^{2(m-1)}}{b^{2m}}\right\}\mathrm{X} = -xy\left(\frac{y^{m-1}}{b^m}\right)\left(\frac{x^{m-2}}{a^m} - \frac{y^{m-2}}{b^m}\right) \quad (115)$$

$$\left\{\frac{x^{2(m-1)}}{a^{2m}} + \frac{y^{2(m-1)}}{b^{2m}}\right\}\mathrm{Y} = xy\left(\frac{x^{m-1}}{a^m}\right)\left(\frac{x^{m-2}}{a^m} - \frac{y^{m-2}}{b^m}\right). \quad (116)$$

If (ξ, η) be the inverse of the point whose coordinates are given by (115) and (116), and k^2 the constant of inversion, we have

$$\xi = \frac{k^2\mathrm{X}}{\mathrm{X}^2+\mathrm{Y}^2} = -\frac{k^2 y^{m-1}}{xy.\, b^m\left(\dfrac{x^{m-2}}{a^m} - \dfrac{y^{m-2}}{b^m}\right)}. \qquad \ldots\ldots\ldots (117)$$

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* The theorems established in this section were discovered by me about three years ago, and were, on the 29th August, 1885, communicated to Mr. W. J. C. Miller, Mathematical Editor of the *Educational Times*, with a view to their publication in that journal. They have since been published as questions 8571, 8707, 8773, 8993, 9049, 9074, 9148, 9162, 9163, 9204; but, while some of these questions have appeared under my name, the others have been, for reasons best known to Mr. Miller himself, ascribed to different gentlemen who had, perhaps, just as much to do with the theorems with which they have been credited, as the proverbial man in the moon.

$$\eta = \frac{k^2 Y}{X^2+Y^2} = \frac{k^2 . \, x^{m-1}}{xy . \, a^m \left(\dfrac{x^{m-2}}{a^m} - \dfrac{y^{m-2}}{b^m}\right)} \quad \text{............} \quad (118)$$

If, now, we eliminate x and y between the equations (117) and (118) by virtue of the relation

$$\left(\frac{x}{a}\right)^m + \left(\frac{y}{b}\right)^m = 1,$$

we shall obtain the equation of the locus sought. For this purpose, we find that

$$\left(\frac{\xi}{+a}\right)^{\frac{m}{m-1}} + \left(\frac{\eta}{-b}\right)^{\frac{m}{m-1}}$$

$$= \left\{\frac{-k^2}{abxy\left[\dfrac{x^{m-2}}{a^m} - \dfrac{y^{m-2}}{b^m}\right]}\right\}^{\frac{m}{m-1}} \quad \text{............} \quad (119)$$

and

$$(b\eta)\left(\frac{\xi}{+a}\right)^{\frac{1}{m-1}} + (a\xi)\left(\frac{\eta}{-b}\right)^{\frac{1}{m-1}}$$

$$= k^2\left\{\frac{-k^2}{abxy\left[\dfrac{x^{m-2}}{a^m} - \dfrac{y^{m-2}}{b^m}\right]}\right\}^{\frac{1}{m-1}} \quad \text{............} \quad (120)$$

Therefore, finally, replacing (ξ, η) by (x, y), we find from (119) and (120) the

Theorem.—The reciprocal polar of the evolute of

$$\left(\frac{x}{a}\right)^m + \left(\frac{y}{b}\right)^m = 1$$

is the curve

$$k^2\left\{\left(\frac{x}{+a}\right)^{\frac{m}{m-1}} + \left(\frac{y}{-b}\right)^{\frac{m}{m-1}}\right\}^{\frac{1}{m}}$$

$$= (by)\left(\frac{x}{+a}\right)^{\frac{1}{m-1}} + (ax)\left(\frac{y}{-b}\right)^{\frac{1}{m-1}}, \quad \text{............} \quad (121)$$

where k is the radius of the circle of inversion.

A host of interesting results may be obtained by assigning particular values to m and k in (121); a few are noted below.

If $m = 2$, $k^2 = a^2 \mp b^2$, we see that the reciprocal polar of the evolute of the conic

$$\frac{x^2}{a^2} \pm \frac{y^2}{b^2} = 1,$$

with regard to the circle described on the line joining the foci as diameter, is the curve

$$\frac{a^2}{x^2} \pm \frac{b^2}{y^2} = 1 \qquad \text{............} \quad (122)$$

which, when the hyperbola is equilateral, becomes

$$\frac{1}{x^2} - \frac{1}{y^2} = \frac{1}{a^2}. \qquad \text{............} \quad (123)$$

Again, if $m = \frac{2}{3}$, $k = 1$, we see that the reciprocal polar of the evolute of the hypocycloid

$$\left(\frac{x}{\alpha}\right)^{\frac{2}{3}} + \left(\frac{y}{\beta}\right)^{\frac{2}{3}} = 1$$

is the curve

$$\left(\frac{x^2}{\alpha^2} + \frac{y^2}{\beta^2}\right)^3 = \left(\frac{x^4}{\alpha^2} - \frac{y^4}{\beta^2}\right)^2, \qquad \text{............} \quad (124)$$

the radius of the circle of inversion being unity; if $\alpha = \beta$, the polar equation of the reciprocal polar becomes

$$r = \alpha \sec 2\theta. \qquad \text{............} \quad (125)$$

Again, since the evolute of the conic

$$\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1$$

is

$$\left(\frac{x}{\alpha}\right)^{\frac{2}{3}} + \left(\frac{y}{\beta}\right)^{\frac{2}{3}} = 1,$$

where

$$\alpha = \frac{a^2 - b^2}{a}, \quad \beta = \frac{a^2 - b^2}{b},$$

we see, by putting $m = \frac{2}{3}$, $k^2 = a^2 - b^2$, that the reciprocal polar of the evolute of the evolute of the conic

$$\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1,$$

with respect to the circle described on the line joining the foci as diameter, is the curve

$$\left(\frac{a^2}{x^2} + \frac{b^2}{y^2}\right)^3 = (a^2x - b^2y)^2 \qquad \text{............} \quad (126)$$

Again, by putting $m = -2$, and attending to equation (122), it is clear that the reciprocal polar of the evolute of the reciprocal polar of the evolute of the conic

$$\frac{x^2}{a^2}+\frac{y^2}{b^2}=1,$$

with regard to the circle described on the line joining the foci as diameter, is the curve

$$\left\{\left(\frac{x}{a}\right)^{\frac{2}{3}}+\left(\frac{y}{b}\right)^{\frac{2}{3}}\right\}\left\{\left(\frac{x}{y}\right)^{\frac{1}{3}}\left(\frac{x}{b}\right)^{\frac{2}{3}}-\left(\frac{y}{x}\right)^{\frac{1}{3}}\left(\frac{y}{a}\right)^{\frac{2}{3}}\right\}^2=\left(\frac{a}{b}-\frac{b}{a}\right)^2 \quad (127)$$

Here we may remark in passing that since the reciprocal polar of the evolute of the reciprocal polar of any curve can be geometrically proved to be the locus of the extremity of the polar subtangent, it is clear that the curve in (127) is the locus of the extremity of the polar subtangent of the evolute of the conic

$$\frac{x^2}{a^2}+\frac{y^2}{b^2}=1.$$

Hence, transforming to polar coordinates, we have the

Theorem.—The locus of the extremity of the polar subtangent of the curve

$$\left(\frac{1}{r}\right)^{\frac{2}{3}}=\left(\frac{a\cos\theta}{a^2-b^2}\right)^{\frac{2}{3}}+\left(\frac{b\sin\theta}{a^2-b^2}\right)^{\frac{2}{3}},$$

which is, of course, the evolute of the conic, is the curve

$$\left(\frac{a}{b}-\frac{b}{a}\right)^2\frac{1}{r^2}=\left\{\left(\frac{\cos\theta}{a}\right)^{\frac{2}{3}}+\left(\frac{\sin\theta}{b}\right)^{\frac{2}{3}}\right\}\times$$

$$\left\{\cot\theta.\left(\frac{\cos\theta}{b}\right)^{\frac{2}{3}}-\tan\theta\left(\frac{\sin\theta}{a}\right)^{\frac{2}{3}}\right\}^2 \quad \ldots\ldots\ldots\ldots (128)$$

which is, of course, the polar form of the equation (127).

Again, by putting $m=\frac{1}{2}$, $k^2=ab$, we find that the reciprocal polar of the evolute of the parabola

$$\left(\frac{x}{a}\right)^{\frac{1}{2}}+\left(\frac{y}{b}\right)^{\frac{1}{2}}=1,$$

with respect to a circle of radius $\sqrt{ab}$, is the cubic curve

$$\frac{y}{x}.\frac{a-y}{b}+\frac{x}{y}.\frac{b-x}{a}=2. \quad \ldots\ldots\ldots\ldots (129)$$

By the application of the same process to the parabola, a variety of new theorems may be obtained, *viz.*, taking the parabola of the n^{th} degree,

$$y=\lambda x^n, \quad \ldots\ldots\ldots\ldots (132)$$

the normal at any point (x, y) is

$$\lambda n x^{n-1}.\,Y+X=x\left(1+\lambda n y x^{n-2}\right), \quad \ldots\ldots\ldots\ldots (131)$$

while the line at right angles to this through the origin is

$$Y - \lambda n x^{n-1} X = 0, \qquad \text{............} \quad (132)$$

so that, at the point of intersection of the lines given by (131) and (132), we have

$$\left\{ 1 + \lambda^2 n^2 x^{2(n-1)} \right\} Y = \lambda n x^{n-1}.\ x.\ (1 + \lambda n y x^{n-2}), \qquad \text{......} \quad (133)$$

$$\left\{ 1 + \lambda^2 n^2 x^{2(n-1)} \right\} X = \qquad x\ (1 + \lambda n y x^{n-2}), \qquad \text{......} \quad (134)$$

and the inverse of the X, Y is given by

$$\xi = \frac{k^2\, X}{X^2 + Y^2} = \frac{k^2}{x\, (1 + \lambda n y x^{n-2})} \qquad \text{............} \quad (135)$$

$$\eta = \frac{k^2\, Y}{X^2 + Y^2} = \frac{k^2.\ \lambda n x^{n-1}}{x\, (1 + \lambda n y x^{n-2})} \qquad \text{............} \quad (136)$$

where ξ, η are the coordinates of a point on the locus sought; hence, eliminating x, y between the equations (135) and (136), by virtue of the relation in (130), we have, after replacing ξ, η by x, y respectively, the

Theorem.—The reciprocal polar of the evolute of the parabola of the n^{th} degree

$$y = \lambda x^n$$

is the curve

$$y x^{n-2} \left(1 + \frac{1}{n}.\ \frac{y^2}{x^2} \right)^{n-1} = \lambda n k^{2(n-1)} \qquad \text{............} \quad (137)$$

where k is the constant of inversion.

As before, by assigning particular values to λ and n in this equation, we may deduce various theorems.

Thus, the reciprocal polar of the evolute of the parabola

$$y^2 = 4ax,$$

with regard to a circle whose diameter is equal to the latus-rectum, is the cubic curve

$$r\ (\cos^2 \theta + \cot^2 \theta) = 4a \cos \theta, \qquad \text{............} \quad (138)$$

of which $x = 2a$ is an asymptote.

Again, the reciprocal polar of the evolute of the parabola

$$y^2 = 4ax,$$

with respect to a circle of radius a, is the cubic

$$x^3 = y^2\ (a - 2x), \qquad \text{............} \quad (139)$$

of which $x = \frac{a}{2}$ is an asymptote.

Again, the reciprocal polar of the evolute of the parabola

$$y^2 = 4a\ (x + a),$$

the focus being now the origin, with regard to a circle whose diameter is equal to the semi-latus-rectum, is the curve

$$r \cot \theta = a \sin \theta, \qquad \text{............} \quad (140)$$

which represents a circular cubic, of which $x = a$ is an asymptote, and the point at infinity a point of inflexion.

Again, the reciprocal polar of the evolute of the evolute of the parabola

$$y^2 = 4a\ (x + 2a),$$

the origin now being the centre of curvature at the vertex, with respect to a circle of radius a, is the quartic

$$y^2\ (3x^2 + 2y^2) = a^3\, x^3. \qquad \text{............} \quad (141)$$

Similarly, the reciprocal polar of the evolute of the parabola

$$y^2 = 4a\ (x + 2a),$$

with respect to a circle of radius k, is the cubic

$$ax^3 = k^2 y^2.$$

It is useful to notice that if we are given any curve

$$u = f(x,\ y) = 0, \qquad \text{............} \quad (142)$$

the normal at any point (x, y) is

$$(\mathrm{Y} - y)\ \frac{du}{dx} = (\mathrm{X} - x)\ \frac{du}{dy}, \qquad \text{............} \quad (143)$$

while the line at right angles to this through the origin is

$$\mathrm{X}\ \frac{du}{dx} + \mathrm{Y}\ \frac{du}{dy} = 0. \qquad \text{............} \quad (144)$$

At the common point of intersection of these two lines, we have

$$\left\{ \left(\frac{du}{dx}\right)^2 + \left(\frac{du}{dy}\right)^2 \right\} \mathrm{X} = -\frac{du}{dy} \left(y\ \frac{du}{dx} - x\ \frac{du}{dy} \right), \qquad \text{............} \quad (145)$$

$$\left\{ \left(\frac{du}{dx}\right)^2 + \left(\frac{du}{dy}\right)^2 \right\} \mathrm{Y} = \quad \frac{du}{dx} \left(y\ \frac{du}{dx} - x\ \frac{du}{dy} \right), \qquad \text{............} \quad (146)$$

whence it follows that if $(\xi,\ \eta)$ be the point inverse to (X, Y), the coordinates are given by

$$\xi = \frac{k^2\, \mathrm{X}}{\mathrm{X}^2 + \mathrm{Y}^2} = -k^2 . \frac{\dfrac{du}{dy}}{y\ \dfrac{du}{dx} - x\ \dfrac{du}{dy}} \qquad \text{............} \quad (147)$$

$$\eta = \frac{k^2\, \mathrm{Y}}{\mathrm{X}^2 + \mathrm{Y}^2} = \quad k^2 . \frac{\dfrac{du}{dx}}{y\ \dfrac{du}{dx} - x\ \dfrac{du}{dy}} \qquad \text{............} \quad (148)$$

Therefore, the equation of the reciprocal polar of the evolute of the curve given by (142) is obtained by eliminating x and y from the three equations (142), (147), (148); and, the general theory being thus given, the question is reduced to one of elimination.

It is interesting to note that if the coordinates of any point on the given curve can be expressed in terms of a single variable parameter ϕ, the coordinates of the corresponding point on the reciprocal polar of the evolute, may be similarly expressed. For, remembering that

$$\frac{\dfrac{du}{dx}}{\dfrac{du}{dy}} = -\frac{dy}{dx},$$

the formulæ in (147) and (148) may be written

$$\xi = k^2 . \frac{1}{y\dfrac{dy}{dx} + x} = k^2 . \frac{\dfrac{dx}{d\phi}}{y\dfrac{dy}{d\phi} + x\dfrac{dx}{d\phi}}$$

$$\eta = k^2 . \frac{\dfrac{dy}{dx}}{y\dfrac{dy}{dx} + x} = k^2 . \frac{\dfrac{dy}{d\phi}}{y\dfrac{dy}{d\phi} + x\dfrac{dx}{d\phi}},$$

so that, if the coordinates of any point on the given curve be given by

$$x = f_1(\phi)$$
$$y = f_2(\phi),$$

we see at once that the coordinates of the corresponding point on the reciprocal polar of the evolute are given by the system

$$\xi = k^2 . \frac{f'_1(\phi)}{f_1(\phi) f'_1(\phi) + f_2(\phi) f'_2(\phi)}.$$

$$\eta = k^2 . \frac{f'_2(\phi)}{f_1(\phi) f'_1(\phi) + f_2(\phi) f'_2(\phi)}.$$

It is clear that the coordinates of any point on the n^{th} "reciprocal polar of evolute" may be obtained from this system; and the coordinates of points on the curves given above may also be expressed by means of a single variable parameter.

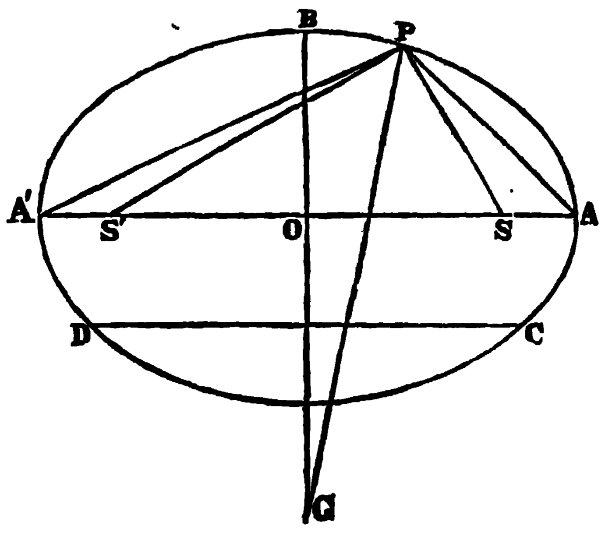
§§. 28—29. *Theorems on Central Conics.*

§. 28. Properties of the Ellipse.—In this section we shall investigate the truth of some theorems on the ellipse.

I. Let ϕ be the eccentric angle at any point P on the ellipse

$$\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1,$$

so that, if A, A′ are the vertices and S, S′ the foci, the coordi-



nates of A, A′, S, S′, P are (a, o), $(-a, o)$, (ae, o), $(-ae, o)$, $(a \cos \phi, b \sin \phi)$, respectively. The equations to PA, PS, PS′, PA′ are easily found, *viz.*,

PA is $$\frac{x - a\cos\phi}{y - b\sin\phi} = \frac{a\cos\phi - a}{b\sin\phi},$$

or $$y = \frac{b}{a}\frac{\sin\phi}{\cos\phi - 1}x - \frac{b\sin\phi}{\cos\phi - 1} \qquad \text{............} \quad (149)$$

PS is $$\frac{x - a\cos\phi}{y - b\sin\phi} = \frac{a\cos\phi - ae}{b\sin\phi},$$

or $$y = \frac{b}{a}\frac{\sin\phi}{\cos\phi - e}x - \frac{be\sin\phi}{\cos\phi - e} \qquad \text{............} \quad (150)$$

PS′ is $$\frac{x - a\cos\phi}{y - b\sin\phi} = \frac{a\cos\phi + ae}{b\sin\phi},$$

or $$y = \frac{b}{a}\frac{\sin\phi}{\cos\phi + e}x + \frac{be\sin\phi}{\cos\phi + e} \qquad \text{............} \quad (151)$$

PA′ is $$\frac{x - a\cos\phi}{y - b\sin\phi} = \frac{a\cos\phi + a}{b\sin\phi},$$

or $$y = \frac{b}{a}\frac{\sin\phi}{\cos\phi + 1}x + \frac{b\sin\phi}{\cos\phi + 1} \qquad \text{............} \quad (152)$$

Let p, q be the intercepts made by PA, PA′, and r, s those made by PS, PS′, on the minor axis. Then we have

$$p = \frac{b\sin\phi}{1 - \cos\phi}, \quad q = \frac{b\sin\phi}{1 + \cos\phi},$$

$$r = \frac{be\sin\phi}{e - \cos\phi}, \quad s = \frac{be\sin\phi}{e + \cos\phi};$$

so that we get

$$p + q = \frac{2b}{\sin\phi}, \quad pq = b^2, \quad \frac{1}{p} + \frac{1}{q} = \frac{2}{b\sin\phi}.$$

$$r + s = \frac{2be^2\sin\phi}{e^2 - \cos^2\phi}, \quad rs = \frac{b^2e^2\sin^2\phi}{e^2 - \cos^2\phi}, \quad \frac{1}{r} + \frac{1}{s} = \frac{2}{b\sin\phi}.$$

This shews that the sum of the reciprocals of the intercepts made by PA, PA′ on the minor axis is equal to the sum of the reciprocals of the intercepts made by PS, PS′ on the same axis; it also follows that, since $pq = b^2$, the rectangle under the intercepts made by PA, PA′ is always constant and equal to the square of the semi-axis-minor. Again, p, q are the roots of the quadratic

$$z^2 - 2b \operatorname{cosec}\phi . z + b^2 = 0. \qquad \text{............} \quad (153)$$

Similarly, r, s are the roots of the quadratic

$$z^2 - 2b\,\lambda^2 \operatorname{cosec}\phi . z + b^2\lambda^2 = 0 \qquad \text{............} \quad (154)$$

where λ^2 satisfies the equation

$$\lambda^2 = \frac{e^2\sin^2\phi}{e^2 - \cos^2\phi},$$

which is equivalent to

$$\frac{\sin^2\phi}{e^2-1}=\frac{}{e^2-\lambda^2}.$$

Again, since the equations of all the four lines PA, PA′, PS, PS′, are known, the angle between any two of them may be found, *viz.*,

$$\tan \text{APA}' = \frac{2\,ab}{(a^2-b^2)\sin\phi} \qquad \ldots\ldots\ldots\ldots \quad (155)$$

$$\tan \text{SPS}' = \frac{2be}{a}\cdot\frac{\sin\phi}{1-e^2\,(1+\sin^2\phi)} \qquad \ldots\ldots\ldots\ldots \quad (156)$$

$$\cot \text{SPA} = -\frac{a}{b}\cdot\frac{1+e}{1-e}\left\{\tan\frac{\phi}{2}-\frac{e^2}{1+e}\sin\phi\right\} \qquad \ldots\ldots\ldots \quad (157)$$

$$\cot \text{S}'\text{PA}' = \frac{a}{b}\cdot\frac{1+e}{1-e}\left\{\cot\frac{\phi}{2}-\frac{e^2}{1+e}\sin\phi\right\}. \qquad \ldots\ldots\ldots \quad (158)$$

We have shewn above that

$$\frac{1}{p}+\frac{1}{q}=\frac{1}{r}+\frac{1}{s}=\frac{2}{b\sin\phi}=\frac{2}{\text{ordinate of P}},$$

whence the ordinate of P is a harmonic mean as well between r and s as between p and q. Again, it is evident that the theorem holds, even if S, S′ are not the foci, but any two points on the major axis equidistant from the centre; for, in that case, instead of putting OS $= ae$, we have to put OS $= ak$, where k is a certain constant; thus, we have the theorem that the ordinate of any point P is a harmonic mean between the intercepts made on the minor axis by the two lines joining P to two points on the major axis equidistant from the centre.

In order to see whether the formulæ

$$\frac{1}{p}+\frac{1}{q}=\frac{1}{r}+\frac{1}{s}=\frac{2}{y},$$

$$pq=k^2,$$

hold for any curve other than the conic, let us take the inverse question in a more general form, *viz.*, take O as the origin of coordinates, and BOA, OQP any two lines through it, A, B being fixed points; then, if BQ and AP intersect in R, required the locus of R, when

$$\frac{1}{p}+\frac{1}{q}=\frac{1}{r}+\frac{1}{s}=\frac{2}{y},$$

$$pq=k^2,$$

where OP $= p$, OQ $= q$. Let α, β be the coordinates of R; OA $= a$, OB $= -b$; then

$$\text{RA is } \frac{x-\alpha}{y-\beta}=\frac{a-\alpha}{\beta},$$

$$\text{RB is } \frac{x-\alpha}{y-\beta}=\frac{\alpha+b}{\beta}.$$

But, since OP $= p$, OQ $= q$, we have

$$\frac{-\alpha}{p-\beta}=\frac{\alpha-a}{\beta},\quad \frac{-\alpha}{q-\beta}=\frac{\alpha+b}{\beta},$$

whence

$$p=\frac{a\beta}{a-\alpha},\quad q=\frac{b\beta}{\alpha+b}, \qquad \text{............ (159), (160)}$$

so that

$$\frac{1}{p}+\frac{1}{q}=\frac{2}{\beta}+\frac{\alpha\,(a-b)}{ab\,\beta}.$$

Hence the theorem that the ordinate is a harmonic mean between the intercepts holds only when $a=b$, that is, when the line on which the intercepts are made is equidistant from the fixed points; thus, we have the

Theorem.—Given two points and a line equidistant from them; then, taking for axes the given line and the line joining the points, the ordinate of any point is a harmonic mean between the intercepts which the lines joining the point to the given points make on the given line.

Again, if $pq=k^2$, we must have, changing α, β into x, y in (159) and (160),

$$\frac{ay}{a-x}\cdot\frac{by}{x+b}=k^2,$$

which may be written

$$\frac{x^2}{ab}+\frac{y^2}{k^2}+\left(\frac{1}{a}-\frac{1}{b}\right)x=1,$$

shewing that the theorem holds only when P lies on a conic. In the particular case when the given line is equidistant from the given points, we have $a=b$, and the conic is

$$\frac{x^2}{a^2}+\frac{y^2}{k^2}=1.$$

If the two lines are also at right angles, they are the axes of the conic, and the given constant k is the semi-axis-minor.

II. To determine the position of a point P on an ellipse such that, if the normal at P intersects the minor axis produced in G, the polar of G may subtend a right angle at P.

Using the same diagram, let the ellipse be

$$\frac{x^2}{a^2}+\frac{y^2}{b^2}=1,$$

and P the required point where the eccentric angle is ϕ, so that the coordinates of P are $a\cos\phi$, $b\sin\phi$. Then the normal at P is

$$\frac{ax}{\cos\phi}-\frac{by}{\sin\phi}=c^2,$$

so that G is

$$\left(0,\,-\frac{c^2\sin\phi}{b}\right).$$

Let CD be the polar of G with respect to the conic, so that CD is parallel to the axis-major and has for its equation

$$y = -\frac{b^3}{c^2 \sin\phi}.$$

Transfer the origin to P, and take the new axes parallel to the old; then the ellipse is

$$\frac{(x+a\cos\phi)^2}{a^2} + \frac{(y+b\sin\phi)^2}{b^2} = 1$$

or

$$\frac{x^2}{a^2} + \frac{y^2}{b^2} + \frac{2\cos\phi}{a}x + \frac{2\sin\phi}{b}y = 0 \quad \ldots\ldots\ldots\ldots (161)$$

The line CD is

$$y + b\sin\phi = -\frac{b^3}{c^2\sin\phi},$$

or

$$y = \lambda \quad \ldots\ldots\ldots\ldots (162)$$

where

$$\lambda = -\frac{b}{c^2\sin\phi}(a^2\sin^2\phi + b^2\cos^2\phi) \quad \ldots\ldots\ldots\ldots (163)$$

Now, PD, PC are two lines through the new origin, and through the intersection of the conic with the line; their equation, therefore, must be

$$\frac{x^2}{a^2} + \frac{y^2}{b^2} + \frac{2\cos\phi}{\lambda a}xy + \frac{2\sin\phi}{\lambda b}y^2 = 0 \quad \ldots\ldots\ldots\ldots (164)$$

These will be at right angles, if

$$\frac{1}{a^2} + \frac{1}{b^2} + \frac{2\sin\phi}{\lambda b} = 0.$$

Substituting for λ from (163) and simplifying, we have

$$\sin^2\phi = \left(1 - \frac{1}{e^2}\right)\left(1 - \frac{2}{e^2}\right) \quad \ldots\ldots\ldots\ldots (165)$$

which determines the value of ϕ, and, therefore, of P; it is remarkable that the result is dependent simply on the eccentricity.

III. A very interesting point arises, if we seek the envelope of the sides of any triangle PSS′ having its vertex P at any point on the ellipse, and its base-ends any two points S, S′ on the axis-major, equidistant from the centre, so that $OS = OS' = k$. Then, from (150), the equation of PS is

$$y = \frac{b}{a}\cdot\frac{\sin\phi}{\cos\phi - k}x - \frac{bk\sin\phi}{\cos\phi - k},$$

which may be written

$$(bx - akb)\sin\phi - ay\cos\phi = -aky,$$

and the envelope of this for different values of ϕ is

$$(bx - akb)^2 + a^2y^2 = a^2k^2y^2, \quad \ldots\ldots\ldots\ldots (166)$$

which is equivalent to

$$b^2(x - ak)^2 = a^2(k^2 - 1)y^2 \quad \ldots\ldots\ldots\ldots (167)$$

or

$$b(x - ak) = \pm a\sqrt{k^2 - 1}\,y;$$

apparently, therefore, the envelope is a pair of right lines passing through the fixed point (ak, o), and real only if k is greater than unity, that is, if the point S is outside the ellipse. But, looking to the geometry of the figure, it is clear that the envelope must be the given point S, so that the analytical solution furnishes, apparently, a whole line for the envelope, while geometrically only one definite point on that line satisfies the demand of the problem; the discrepancy, however, is only apparent, *viz.*, the equation (167) may be written

$$b^2 (x-ak)^2 + a^2 (\sqrt{1-k^2})^2 y^2 = 0,$$

so that this must be equivalent to

$$\left.\begin{aligned} x &= ak \\ y &= 0 \end{aligned}\right\},$$

which is, of course, the point in question. Such instances of degenerate envelopes are by no means rare.

§. 29. Properties of Confocals.

I. Given a system of confocal ellipses, to find the locus of points where the tangents cut off a constant area from the axes.

Any conic of the system is

$$\frac{x^2}{A^2} + \frac{y^2}{B^2} = 1, \qquad \text{............} \ (168)$$

where, for the moment,

$$A^2 = a^2 + \lambda^2, \ B^2 = b^2 + \lambda^2, \ c^2 = A^2 - B^2 = a^2 - b^2.$$

Take a point (ξ, η) on this ellipse where the eccentric angle is ϕ; the tangent is

$$\frac{x}{A} \cos \phi + \frac{y}{B} \sin \phi = 1,$$

and the intercepts made on the axes are

$$\frac{A}{\cos \phi}, \ \frac{B}{\sin \phi},$$

so that, if h^2 be double the constant area in question, we have

$$\frac{AB}{\sin \phi \cos \phi} = h^2 \qquad \text{............} \ (169)$$

Hence we get the system

$$\xi^2 = A^2 \cos^2 \phi = (a^2 + \lambda^2) \cos^2 \phi, \qquad \text{............} \ (170)$$

$$\eta^2 = B^2 \sin^2 \phi = (b^2 + \lambda^2) \sin^2 \phi, \qquad \text{............} \ (171)$$

and from (169)

$$(a^2 + \lambda^2)(b^2 + \lambda^2) = h^4 \sin^2 \phi \cos^2 \phi. \qquad \text{............} \ (172)$$

The elimination of λ, ϕ from these three equations will lead us to the equation of the locus. For this purpose, observe that from (170) and (171),

$$\xi^2 \eta^2 = (a^2 + \lambda^2)(b^2 + \lambda^2) \sin^2 \phi \cos^2 \phi = h^4 \sin^4 \phi \cos^4 \phi,$$

so that

$$\xi\eta = h^2 \sin^2\phi \cos^2\phi. \qquad \text{............} \quad (173)$$

Again, from (170) and (171),

$$\frac{\xi^2}{\cos^2\phi} - \frac{\eta^2}{\sin^2\phi} = a^2 - b^2 = c^2,$$

or

$$\xi^2 \sin^2\phi - \eta^2 \cos^2\phi = c^2 \sin^2\phi \cos^2\phi = \frac{c^2\,\xi\eta}{h^2},$$

from (173).

This may be written

$$\xi^2 \sin^2\phi - \eta^2 (1 - \sin^2\phi) = \frac{c^2}{h^2}\,\xi\eta,$$

whence

$$\sin^2\phi = \frac{\eta^2}{\xi^2+\eta^2} + \frac{c^2}{h^2}\,\frac{\xi\eta}{\xi^2+\eta^2}, \qquad \text{............} \quad (174)$$

$$\cos^2\phi = \frac{\xi^2}{\xi^2+\eta^2} - \frac{c^2}{h^2}\,\frac{\xi\eta}{\xi^2+\eta^2}. \qquad \text{............} \quad (175)$$

Substituting for sin ϕ and cos ϕ from (174) and (175) in (173), and simplifying, we have

$$(c^2\xi + h^2\eta)(h^2\xi - c^2\eta) = h^2\,(\xi^2+\eta^2)^2,$$

which is the equation of the locus in question. Hence, we have the theorem that the locus of points on a system of confocal ellipses where the tangents cut off a constant area from the axes is the bicircular quartic through the origin

$$(c^2x + h^2y)(h^2x - c^2y) = h^2\,(x^2+y^2)^2, \qquad \text{............} \quad (176)$$

where c is half the distance between the foci, and h^2 double the given constant area.

It is not difficult to see that this quartic-locus is the inverse of a central conic, for, substituting for x and y

$$\frac{k^2x}{x^2+y^2}, \quad \text{and} \quad \frac{k^2y}{x^2+y^2}$$

respectively, we find that the bicircular quartic is the inverse of the conic

$$(c^2x + h^2y)(h^2x - c^2y) = h^2 k^4, \qquad \text{............} \quad (177)$$

where k is the radius of inversion; it is easy to see that this conic is an equilateral hyperbola concentric with the confocal ellipses, and, if θ be the inclination of its transverse axis to the line joining the foci of the confocal family, we have

$$\tan 2\theta = \tfrac{1}{2}\left(\frac{h^2}{c^2} - \frac{c^2}{h^2}\right),$$

which furnishes for tan θ the two values

$$\frac{h^2-c^2}{h^2+c^2}, \quad \frac{c^2+h^2}{c^2-h^2}.$$

II. To investigate the locus of points on a system of confocal ellipses, where the eccentric angle has a constant value.

Let any one of the confocal system be

$$\frac{x^2}{A^2}+\frac{y^2}{B^2}=1$$

where $A^2=a^2+\lambda^2$, $B^2=b^2+\lambda^2$; then, if ϕ be the eccentric angle at any point (ξ, η), we have

$$\xi^2=A^2\cos^2\phi=(a^2+\lambda^2)\cos^2\phi,$$
$$\eta^2=B^2\sin^2\phi=(b^2+\lambda^2)\sin^2\phi,$$

so that the locus in question is the hyperbola

$$\frac{\xi^2}{\cos^2\phi}-\frac{\eta^2}{\sin^2\phi}=a^2-b^2=c^2, \qquad \ldots\ldots\ldots\ldots \ (178)$$

and this is evidently a member of the confocal family; hence it follows that, given a system of confocal ellipses, the locus of points where the eccentric angle has a constant value is one of the confocal hyperbolas which intersect the system orthogonally; in other words, given a confocal system of ellipses and hyperbolas, each hyperbola intersects the ellipses at points where the eccentric angle has a constant value, and, by variation of this constant value, we get all the hyperbolas of the system, and, from a known theorem, the envelope of all these hyperbolas is an imaginary quadrilateral.

Similarly, if we have the hyperbola

$$\frac{x^2}{a^2+\lambda^2}-\frac{y^2}{b^2+\lambda^2}=1,$$

which is one of a confocal system, and ϕ the eccentric angle at any point (ξ, η), we have

$$\xi^2=(a^2+\lambda^2)\sec^2\phi,$$
$$\eta^2=(b^2+\lambda^2)\tan^2\phi,$$

so that, if the eccentric angle has a constant value, the locus is

$$\frac{\xi^2}{\sec^2\phi}-\frac{\eta^2}{\tan^2\phi}=a^2-b^2=c^2 \qquad \ldots\ldots\ldots\ldots \ (179)$$

and the envelope of this, for different values of the eccentric angle, is the parallelogram formed by the four lines

$$(c^2+y^2-x^2)^2=4c^2y^2, \qquad \ldots\ldots\ldots\ldots \ (180)$$

viz., the four lines are

$$-c+y+x=0,\ c-y+x=0,\ c+y-x=0,\ c+y+x=0.$$

§§. 30—31. *Theorems on the Parabola.*

§. 30. **A Dynamical Problem.**—Take the parabola

$$y^2=4ax,$$

which, when the origin is removed to a point on the principal axis at a distance na from the vertex, becomes

$$y^2=4a\,(x+na). \qquad \ldots\ldots\ldots\ldots \ (181)$$

Imagine a particle to describe the parabola under the action of a force directed to the new origin as centre; and suppose it to be started from the apse with the velocity in a circle at the same distance. Then

$$2y\frac{dy}{dt}=4a\frac{dx}{dt},$$

and
$$\left(\frac{dy}{dt}\right)^2+y\frac{d^2y}{dt^2}=2a\frac{d^2x}{dt^2}.$$

But
$$x\frac{dy}{dt}-y\frac{dx}{dt}=h,$$

so that
$$x\frac{dy}{dt}-\frac{y^2}{2a}\frac{dy}{dt}=h,$$

whence
$$(x+2na)\frac{dy}{dt}=-h.$$

Therefore
$$\frac{h^2}{(x+2na)^2}-\mathrm{P}\frac{y^2}{r}=-2a.\ \mathrm{P}.\ \frac{x}{r},$$

where P is the central force.

This may be written

$$\frac{h^2}{(x+2na)^2}=\frac{\mathrm{P}}{r}(y^2-2ax)=\frac{\mathrm{P}}{r}.\ 2a\,(x+2na),$$

which gives

$$\mathrm{P}=\frac{h^2}{2a}\,\frac{1}{(x+2na)^3}. \qquad \text{............ (182)}$$

But
$$x^2+y^2=r^2$$
$$y^2=4a\,(x+na).$$

Eliminating y, this gives a quadratic for x, whence we derive

$$x+2na=2a\,(n-1)+\left\{r^2+4a^2(1-n)\right\}^{\frac{1}{2}}.$$

Substituting in (182), we get

$$\mathrm{P}=\frac{h^2}{2a}\,\frac{r}{\left\{2a\,(n-1)+\sqrt{r^2+4a^2\,(1-n)}\right\}^3} \qquad \text{............ (183)}$$

which gives the law of force in terms of the radius vector. For an interesting discussion of a kinetic difficulty in connection with this dynamical problem, see a note by Dr. Besant in the *Quarterly Journal of Mathematics*, t. XI, 38.

§. 31. **Geometrical Applications.**—Thus far we have solved a purely dynamical question; we now proceed to obtain some interesting geometrical properties of the parabola. We have

$$\mathrm{P}=\frac{h^2}{p^3}\frac{dp}{dr} \quad \frac{h^2}{2}\frac{d}{dr}\left(\frac{1}{p^2}\right).$$

Hence, from (183), we get

$$-\frac{a}{p^2}=\int\frac{rdr}{\left\{2a\,(n-1)+\sqrt{\left[r^2+4a^2\,(1-n)\right]}\right\}^3}.$$

If, therefore, we take p for all values of r from $+\infty$ to $-\infty$, we have

$$\Sigma\left(-\frac{a}{p^2}\right)=2\int_{\infty}^{na}\frac{rdr}{\left\{2a\,(n-1)+\sqrt{\left[r^2+4a^2\,(1-n)\right]}\right\}^3}\qquad(184)$$

To evaluate this definite integral, let us first take the indefinite form. Put

$$r^2=4a^2\,(1-n)\,\tan^2\phi,\qquad\ldots\ldots\ \ldots\ (185)$$

$$r=2a\sqrt{1-n}\,\tan\phi,$$

$$dr=2a\sqrt{1-n}\,\sec^2\phi\,d\phi,$$

$$r^2+4a^2\,(1-n)=4a^2\,(1-n)\,\sec^2\phi.$$

If, therefore, I be the indefinite integral, we have

$$\mathrm{I}=\int\frac{4a^2\,(1-n)\,\tan\phi\,\sec^2\phi\,d\phi}{\left\{2a\,(n-1)+2a\sqrt{1-n}\,\sec\phi\right\}}$$

$$=\int\frac{4a^2\,(1-n)\,\sin\phi\,d\phi}{\left\{2a\sqrt{1-n}-2a\,(1-n)\,\cos\phi\right\}^3}$$

$$=\int\frac{4a^2\,(1-n)\,\sin\phi\,d\phi}{8a^3\,(1-n)^{\frac{3}{2}}\left\{1-\sqrt{1-n}\,\cos\right.}$$

$$=-\frac{1}{2a\sqrt{1-n}}\int\frac{d\,(\cos\phi)}{\left\{1-\sqrt{1-n}\,\cos\phi\right\}}$$

$$=\frac{1}{4a\,(n-1)}\,\frac{1}{\left\{1-\sqrt{1-n}\,\cos\phi\right\}^2}.\quad\ldots.\quad(186)$$

Now, $\sec^2\phi=1+\tan^2\phi=1+\frac{r^2}{4a^2\,(1-n)}$, from (185).

Therefore

$$\cos^2\phi=\frac{4a^2\,(1-n)}{r^2+4a^2\,(1-n)},$$

and, when $r=na$, this gives

$$\cos^2\phi=\frac{4\,(1-n)}{(2-n)^2}$$

and, when $r=\infty$,

$$\cos^2\phi=0.$$

These give the limits of the transformed integral; if, therefore, Q be the value of the definite integral, we have

$$Q = -\frac{1}{an^2},$$

so that, from (184), we have

$$a\,\Sigma\left(-\frac{1}{p^2}\right) = 2Q = -\frac{2}{an^2},$$

whence, finally,

$$\Sigma\left(\frac{1}{p^2}\right) = \frac{2}{a^2n^2}. \qquad \text{............} \quad (187)$$

Hence we have the theorem that, if we take any point on the axis of a parabola whose distance from the vertex is na, the sum of the squares of the reciprocals of all the perpendiculars dropped from this point on successive tangents to the parabola is equal to $\dfrac{2}{n^2a^2}$. It is obvious that these perpendiculars are the radii-vectores of a pedal of the parabola; hence, the following theorems may be enunciated.

Theorem I.—A is the vertex and S_1 the focus of a parabola whose latus-rectum is $4a$; points S_2, S_3, ... S_∞ are taken on the principal axis such that $AS_1 = S_1S_2 = \ldots = a$; the sum of the squares of the reciprocals of the radii-vectores of the pedal of the parabola with regard to S_n is $\dfrac{2}{n^2a^2}$. (188)

Theorem II.—The sum of the squares of the reciprocals of the radii-vectores of all the pedals of the parabola with regard to $S_1, S_2 \ldots S_\infty$ is

$$= \frac{2}{a^2}\left(\frac{1}{1^2} + \frac{1}{2^2} + \ldots\ldots\right) = \frac{1}{3}\left(\frac{\pi}{a}\right)^2 \qquad \text{.........} \quad (189)$$

Theorem III.—If we take only the odd pedals, the sum of the squares of the reciprocals of all the radii-vectores is

$$= \frac{2}{a}\left(\frac{1}{1^2} + \frac{1}{3^2} + \ldots\ldots\right) = \frac{1}{4}\left(\frac{\pi}{a}\right)^2 \qquad \text{.........} \quad (190)$$

Theorem IV.—If we take only the even pedals, the sum of the squares of the reciprocals of all the radii-vectores is

$$= \frac{2}{a}\left(\frac{1}{2^2} + \frac{1}{4^2} + \ldots\ldots\right) = \frac{1}{12}\left(\frac{\pi}{a}\right)^2 \qquad \text{.........} \quad (191)$$

§. 32. *A Geometrical Locus.*

§. 32. **General Theorem on Conics.**—If from any point P two tangents be drawn to the conic

$$\frac{x^2}{a^2} + \frac{y^2}{b^2} = 1, \qquad \text{...............} \quad (192)$$

to investigate the locus of the middle point of the chord of contact when

P is constrained to move on any curve

$$F(x, y) = 0. \quad \ldots\ldots\ldots\ldots\ldots \quad (193)$$

Let θ, ϕ be the eccentric angles at the points of contact of the tangents; then the tangents are

$$\frac{x}{a}\cos\theta + \frac{y}{b}\sin\theta = 1,$$

$$\frac{x}{a}\cos\phi + \frac{y}{b}\sin\phi = 1,$$

and, if X, Y be the coordinates of P, we have

$$X = a.\frac{\cos\frac{\theta+\phi}{2}}{\cos\frac{\theta-\phi}{2}}.$$

$$Y = b.\frac{\sin\frac{\theta+\phi}{2}}{\cos\frac{\theta-\phi}{2}}.$$

If, further, ξ, η be the coordinates of the middle point of the chord of contact the locus of which is sought, we have

$$\xi = \frac{a}{2}(\cos\theta+\cos\phi) \quad \ldots\ldots\ldots\ldots \quad (194)$$

$$\eta = \frac{b}{2}(\sin\theta+\sin\phi) \quad \ldots\ldots\ldots\ldots \quad (195)$$

The locus is obtained by eliminating θ, ϕ between these and

$$F\left\{a\frac{\cos\frac{\theta+\phi}{2}}{\cos\frac{\theta-\phi}{2}},\ b\frac{\sin\frac{\theta+\phi}{2}}{\cos\frac{\theta-\phi}{2}}\right\} = 0 \quad \ldots \quad (196)$$

From (194) and (195), we have

$$\frac{\xi}{a} = \cos\frac{\theta+\phi}{2}\cos\frac{\theta-\phi}{2}$$

$$\frac{\eta}{b} = \sin\frac{\theta+\phi}{2}\cos\frac{\theta-\phi}{2}.$$

whence, squaring and adding,

$$\cos^2\frac{\theta-\phi}{2} = \frac{\xi^2}{a^2} + \frac{\eta^2}{b^2}. \quad \ldots\ldots\ldots\ldots \quad (197)$$

Also, by division, from (194) and (195),

$$\tan\frac{\theta+\phi}{2} = \frac{a\eta}{b\xi}$$

whence

$$\sin\frac{\theta+\phi}{2} = \frac{a\eta}{\sqrt{b^2\xi^2+a^2\eta^2}},\quad \cos\frac{\theta+\phi}{2} = \frac{b\xi}{\sqrt{b^2\xi^2+a^2\eta^2}} \quad \ldots\ldots\ldots \quad (198), (199)$$

Substituting from (197), (198), and (199) in (196), the equation of the locus sought is found to be

$$F\left(\frac{a^2b^2\xi}{b^2\xi^2+a^2\eta^2}, \frac{a^2b^2\eta}{b^2\xi^2+a^2\eta^2}\right)=0. \qquad \ldots\ldots\ldots\ldots (200)$$

We have, therefore, the

Theorem.—If from any point P, tangents are drawn to the conic

$$S \equiv \frac{x^2}{a^2}+\frac{y^2}{b^2}-1=0,$$

and P is constrained to move on any curve

$$F(x, y)=0,$$

the locus of the middle point of the polar chord of P with regard to S is

$$F\left(\frac{x}{1+S}, \frac{y}{1+S}\right)=0.$$

Similarly, if we consider the parabola

$$y^2=4ax,$$

any two points on the curve are

$$(a \tan^2\theta, 2a \tan\theta), (a \tan^2\phi, 2a\tan\phi),$$

so that the coordinates of the point of intersection of the tangents are given by

$$X=a\tan\theta\tan\phi$$

$$Y=a(\tan\theta+\tan\phi),$$

and the middle point of the polar chord is given by

$$\xi=\frac{a}{2}(\tan^2\theta+\tan^2\phi),$$

$$\eta=a(\tan\theta+\tan\phi).$$

These give

$$\frac{\eta^2}{a^2}=\frac{2\xi}{a}+2\tan\theta\tan\phi,$$

whence

$$X=\frac{\eta^2-2a\xi}{2a}, \quad Y=\eta.$$

Hence, substituting in F $(x, y)=0$, we have the

Theorem.—If from any point P tangents are drawn to the parabola

$$y^2=4ax,$$

and P is constrained to move on the curve

$$F(x, y)=0,$$

the locus of the middle point of the polar chord of P with regard to the parabola is

$$F\left(\frac{y^2-2ax}{2a}, y\right)=0.$$

We will here simply add that the result obtained above in equation (200) is an immediate consequence of a new method which we propose to call the **Method of Elliptic Inversion.**

26th October, 1887.

Substituting from (197), (198), and (199) in (196), the equation of the locus sought is found to be

$$F\left(\frac{a^2b^2\xi}{b^2\xi^2+a^2\eta^2},\ \frac{a^2b^2\eta}{b^2\xi^2+a^2\eta^2}\right)=0. \quad \ldots\ldots\ldots\ldots (200)$$

We have, therefore, the

Theorem.—If from any point P, tangents are drawn to the conic

$$S\equiv\frac{x^2}{a^2}+\frac{y^2}{b^2}-1=0,$$

and P is constrained to move on any curve

$$F(x,y)=0,$$

the locus of the middle point of the polar chord of P with regard to S is

$$F\left(\frac{x}{1+S},\ \frac{y}{1+S}\right)=0.$$

Similarly, if we consider the parabola

$$y^2=4ax,$$

any two points on the curve are

$$(a\tan^2\theta,\ 2a\tan\theta),\quad (a\tan^2\phi,\ 2a\tan\phi),$$

so that the coordinates of the point of intersection of the tangents are given by

$$X=a\tan\theta\tan\phi$$
$$Y=a(\tan\theta+\tan\phi),$$

and the middle point of the polar chord is given by

$$\xi=\frac{a}{2}(\tan^2\theta+\tan^2\phi),$$
$$\eta=a(\tan\theta+\tan\phi).$$

These give

$$\frac{\eta^2}{a^2}=\frac{2\xi}{a}+2\tan\theta\tan\phi,$$

whence

$$X=\frac{\eta^2-2a\xi}{2a},\quad Y=\eta.$$

Hence, substituting in $F(x,y)=0$, we have the

Theorem.—If from any point P tangents are drawn to the parabola

$$y^2=4ax,$$

and P is constrained to move on the curve

$$F(x,y)=0,$$

the locus of the middle point of the polar chord of P with regard to the parabola is

$$F\left(\frac{y^2-2ax}{2a},\ y\right)=0.$$

We will here simply add that the result obtained above in equation (200) is an immediate consequence of a new method which we propose to call the **Method of Elliptic Inversion.**

26th October, 1887.

XXI.—*A Descriptive List of the* Uredineæ *occurring in the Neighbourhood of Simla (Western Himalayas).*—*By* A. BARCLAY, M. B., *Bengal Medical Service.*

[Received 7th October ;—Read November 2nd, 1887.]

(With Plates XII.—XV.).

The neighbourhood of Simla is particularly rich in species of Uredines; and, as I have paid much attention to them during the last four years, it has been suggested to me that a descriptive list of them might usefully be recorded for the use of future workers in this very interesting field of cryptogamic botany. I have acted on the suggestion after much hesitation, for, with the very limited leisure at my disposal in the course of an active official life, I cannot hope to make the list a complete one, nor, indeed, can the descriptions of many of those I notice be as complete as might be desired. Nevertheless, so far as they go, my statements may, I hope, be accepted as correct in every respect, for every one of them has been made after careful and repeated observation. I may, therefore, be permitted to hope that the list may serve some useful purpose, more especially as no such attempt has ever before been made in India, so far as I am aware.

With regard to the order in which such a list should be given, I have determined, after some hesitation, to bind myself by no very strict rule, but, in general, to enumerate, first, all those species which bear aecidial fructification and, then, to go on to those which are at present known to me only in the teleutosporic stages. With reference to the æcidium-bearing species, I may note that I have described them generally as they occur in seasonal sequence, beginning with those which appear earliest in spring, and ending with those which disappear last towards autumn. The only exception I have made in following out this plan is to withdraw from the general list all those forms which occur on the Coniferæ, as I thought it better to enumerate the characters of these few well defined species together, rather than to disperse them among the others, which occur on hosts having no special relationship with one another.

In the present contribution, I will confine myself to the æcidial forms with which I am acquainted on hosts other than the Coniferæ; but, before proceeding to a description of them, I may draw the attention of the reader to one or two points of special interest concerning them.

In the first place, it will be observed that I have related several of them with a mark of interrogation to species already described as occurring in Europe. Until the complete life-histories of those are known, it is impossible to state definitely whether they are correctly so related or not. They are probably all varieties of, or identical with, the European forms with which I have associated them. In only one case (that of *Æcidium Urticæ*, Schum.) has the life-history of the Indian variety been fully traced.

Five of the species described are I believe quite new, in only one of which (*Æcidium Strobilanthis*) have I been able to trace the whole life-history. That on the wild strawberry (*Fragaria vesca*) appears to be a complete autoecious Uredine, but I have unfortunately not been able to prove this by actual experiment. And, in this connection, I would again draw attention to the inconvenience caused by the system of nomenclature now adopted of naming species of Uredines after their teleutosporic forms, an inconvenience which it appears to me will increase as our knowledge of this family is extended, for it sometimes happens that a host bearing an æcidium bears also a teleutospore, which, however, has no relationship whatever with the æcidium. For example, according to this principle, I have been obliged to name the Æcidium which occurs on *Valeriana Wallichii Uromyces Valerianæ*, although I have abundant evidence that the teleutospores have no genetic relationship whatever with the Æcidium. In all probability, future investigation will show that the Uromyces borne on this host is related to some other Æcidium on an entirely different host, whilst the teleutospores borne on some other host are related to the Æcidium on the Valeriana in question. In the cases of *Strobilanthes Dalhousianus* and *Urtica parviflora*, which bear Æcidia whose complete life-histories are known, teleutospores (puccinia) are also borne, which, however, have no relationship with the Æcidia.* The Æcidium on *Jasminum revolutum* presents no unusual features, but those on *Euphorbia cognata* and *Andrachne cordifolia* display aberrant features of great interest. Indeed, these two Æcidia differ so markedly from all others that I have regarded them, provisionally, and until I shall have had further opportunities of working out their complete life-histories, as belonging to a new genus, which I propose calling Monosporidium.

With these introductory remarks I shall pass on to a description of the several species.

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* *See* "Scientific Memoirs by Medical Officers of the Army of India," Part II, Calcutta, 1887.

I.—ÆCIDIAL FORMS.

1.—ÆCIDIUM SANICULÆ, sp. nov.

Sanicula (Europæa, L. ?)

The earliest Æcidium which I have observed in Simla is that which occurs on *Sanicula Europæa.* Towards the latter end of March, some of the earliest leaves of this plant which are being unfolded in spring may be found attacked by this parasite. It is by no means an uncommon fungus. The invaded areas of the leaf are usually small, and generally convex below, where the aecidial cups are usually borne, though a few may open also on the upper surface of the leaf. The æcidia discharge their spores through a *porous* like opening at their summits, *i. e.*, the peridium does not open widely as in most cases with the fragments of the torn tissue forming a *stellate* opening. The petioles are also frequently attacked and at such places they are thickened and often bent. A single leaf blade may present from one to three patches of invasion, these patches being slightly paled in colour as seen from the upper surface.

Æcidiospores.—The moistened æcidiospores measure on an average 25·4 × 19·4 μ, the measurements exhibiting extremes of 26 μ in length and 20 μ in breadth. The epispore is finely punctated and contains from two to three germ pores. The endospore is very fine and not readily distinguishable from the epispore (Fig. 1, Pl. XII.). The spores, when placed in water under suitable circumstances, readily germinate, throwing out long curved tubes measuring 6 to 7 μ in diameter. Only one germinal tube is produced by each spore. The peridial cells measure about 30 × 22 μ (Fig. 2, Pl. XII.).

Remarks.—This æcidium is, I believe, a new species; but may be compared with that which I have described below on *Pimpinella diversifolia.*

2.—UROMYCES VALERIANÆ, Schum ?

Valeriana Wallichii, D. C.

Next to the foregoing Æcidium one on this plant is among the earliest of these parasites to be found in spring. Towards the end of March, some plants may be found in initial stages of attack; but it is towards the latter part of April that it is seen in its fullest development. This Æcidium is one of the most common and abundant in Simla, and individual plants are often so extensively affected in blade and petiole as to be completely destroyed. The affection is usually confined to the blades and petioles of the radical leaves, but may also be found on the upper leaves of the flowering stalks and even, though rarely, on the bracts of the flower heads. When a leaf is extensively affected, it is considerably distorted, and the parts actually invaded by the mycelium are considerably thickened. At an early stage of the affection, patches of pale yellow discoloration may be observed on the leaf blades, which are usually convex above. On this upper convex surface, a few spermogonia may be seen, whilst the æcidial fructification usually emerges from the lower or concave side. The æcidia consist of short tubular peridia filled with reddish yellow spores bursting at their summits in a stellate way.

The spermoginia are remarkably few and their mouths are surmounted by a tuft of paraphyses.

The æcidial affection above described is met with abundantly throughout the time the plants are in flower, but, as soon as the seeds are being matured, towards the middle or end of May, this affection disappears entirely. After an interval of some weeks from the time the æcidial parasite has entirely disappeared, these plants are seen to be attacked by a teleutospore-bearing mycelium also mainly on the radical leaves, though occasionally also on others. This affection always appears on leaves which bear no trace of formerly having borne the æcidial parasite. The spores are extruded from dark brown pustules of minute size, which usually occur in great numbers on each affected leaf. Each pustule is surrounded by a zone of yellow discoloration. At first, these spores are extruded only from the upper surface of the leaf, but later also from the lower surface, exactly opposite the site of the upper spore bed and therefore from the same mycelium. The lower pustule is usually smaller than the upper. At first, when a spore pustule exists only in the upper surface of the leaf, the affected area bulges upwards (convex upwards) with a corresponding concavity below; but this disappears when the lower surface is also involved in spore extrusion.

Æcidiospores.—These are abstricted serially from basidia arranged on a flat hymenium. They are pale orange-yellow round or oval bodies measuring, when dry, 17 × 15 μ and, after lying some time in water, 22 × 20 μ (Fig. 12, Pl. XII.). The epispore is smooth and unmarked. They do not germinate readily in water (Fig. 10, Pl. XIII.). The peridium consists of a layer of single cells.

Teleutospores.—These are brown single-celled bodies—Uromyces—borne singly on stalks (Fig. 13, Pl. XII.). They are somewhat pear-shaped, measuring when moist 25 × 22 μ, and the stalks bearing them are about twice the length of the long diameter of the spore. The spores are readily detached from their beds without any portion of the stalk adhering to them. The epispore is firm and resistant and a little thickened towards the base, where it joins the stalk. It is sparsely beset externally with tubercles. A few fine paraphyses usually occur among the spores. Most spores exhibit a nuclear space or body in the centre. Although I placed them in several nutritive solutions and in water, I never observed them germinating.

Remarks.—I have made very numerous experiments with the view of tracing the life-history of this very common Æcidium, but without success. I am quite convinced that the teleutospore-bearing fungus has no connection whatever with that bearing the æcidium, not only because many carefully conducted experiments failed to establish any such connection, but also because a considerable interval elapses, as I have already noted, between the complete disappearance of the Æcidium and the appearance of the teleutospores. I have also attempted to reproduce the Æcidium by inoculating leaves with almost every teleutospore with which I am acquainted, and most of which I hope to describe later in this series.

This fungus may be identical with *Uromyces Valerianæ*, Schum, in which the æcidiospores are stated to measure 17 × 24 μ and the Uromyces spores, 20 to 26 by 15 to 19. The latter fungus, however, also possesses uredospores, which are entirely absent in the Himalayan species.

3.—PUCCINIA VIOLÆ, Schum ?

Viola serpens, Wall.

An Æcidium of a very destructive kind is extremely common on *Viola serpens* in spring (April) and occurs simultaneously with that described on Valeriana. As a rule, large areas of the leaves become affected and very frequently the petiole also is extensively involved. Sometimes there is scarcely a portion of the whole leaf, blade and stalk, which is not involved, and, in such cases, the whole leaf speedily succumbs to the parasite. In such extreme cases, the blade of the leaf is crumpled up almost beyond recognition, while the affected stalk is bent in various directions and considerably hypertrophied. Limited patches on the leaf blade are generally round and very deeply bulged downwards, *i. e.*, with a concavity upwards. The æcidia are borne most usually on the under surface of the leaf, but a few burst forth also from above. But little discoloration is caused by the mycelium on the upper surface of the leaf, which is only slightly paled.

Later in the season, about the beginning of June, when the æcidial fungus has disappeared, the new leaves of the violet are often attacked by another puccinia-bearing parasite. Many leaves may now be found, in the same localities where formerly the æcidial parasite was common, studded with numerous dark brown or black pustules of the size of a small pin's head, mostly on the under surface. These pustules are irregularly scattered over the leaf blade, bursting through the epidermis (after having raised it considerably) by a clean rent. Opposite the pustules, on the upper surface of the leaf, small greenish yellow spots may be seen. Although the greater number of pustules emerge from the lower surface, yet many also burst forth from the upper surface, especially when the leaf is very largely attacked (Figs. 4 & 5, Pl. XII.).

It has been stated above that these puccinia-pustules are usually borne on newly unfolded leaves, but, in one or two instances, I found the dried up remains of *æcidial* patches on the petioles of leaves which bore these teleutospores. This observation naturally led me to think that the two forms were genetically related, and I accordingly made numerous attempts to establish the relationship upon experimental grounds, but always without success. I am therefore inclined now to regard the two parasites as entirely distinct, and I am supported in this view here, as in the case of Valeriana above, by the fact that, as a rule, a distinct interval of about a month or more elapses between the complete disappearance of the æcidium and the appearance of the teleutospores; and it is quite exceptional to find any trace of old æcidia on plants bearing the puccinia-producing mycelium. I may here note that I have made numerous attempts during the last two years to connect the Æcidium on the violet with several teleutospores occurring on various plants in Simla, but, as in the case of the even more common Valeriana Æcidium, always without success.

Æcidiospores.—When well moistened in water, the spores measure 21 × 18 μ, but, when dry or immediately after immersion in water, they measure on an average 19 × 14·8 μ. They readily germinate in water, throwing out a single more or less sinuate tube measuring about 6 μ in diameter (Fig. 6, Pl. XII.). This germ-tube has a tendency to throw out short lateral branches. The orange-red contents of the spore wander into the furthest end of the tube. The spores appear to have 3 to 4 germinal pores, but only one germ-tube is formed by each.

Teleutospores.—These are dark brown puccinia easily detached from their beds without any portion of the stalk remaining adherent (Fig. 7, Pl. XII.). When dry, these spores measure as follows:—whole length, 30 μ; length of upper cell, 14 μ; length of lower cell, 16 μ; breadth at septum, 18 μ. The spores are somewhat thickened at their free ends, sometimes to the extent of 4 μ. Among these puccinia-spores, a few single-celled spores were often found which may have been either uredospores or a second form of teleutospore. They are brown bodies with thick resistant walls covered externally with prominent tubercles. They measure, when dry, 20 × 18 μ on an average: I never observed their germination. Some freshly collected spores were placed in water in a growing cell on the 20th March, and they germinated freely, although some spores preserved in botanical drying paper since the previous autumn had lost vitality (Figs. 7 & 8, Pl. XII.). The promycelium from the upper cell emerges from the apex, whilst that from the lower cell emerges from a point close to the septum. The promycelium produces four sporidia from four cells into which the end of the promycelium is divided, the most distant one being produced upon a sterigma arising from the very apex of the germ-tube (Figs. 7, 8, 9, Pl. XII.). The sporidia are oval, measuring from 6 × 4 μ to 7 × 5 μ (Fig. 10, Pl. XII).

Remarks.—It is possible that this fungus is identical with, or, more probably, a variety of, *Puccinia Violæ*, Schum., although the measurements of the latter given by Winter* do not agree with mine very nearly. Winter's measurements are as follows:—æcidiospores 16 to 24 μ by 10 to 18 μ (average 20 × 14 μ) against my measurement of 21 × 18; uredospores 19 to 26 μ in diameter against my measurement of 20 × 18 μ; teleutospores 20 to 35 μ by 15 to 20 μ (average 27·5 × 17·5) against my measurements of 30 × 18 μ. The characters of the teleutospores as given by Winter agree with those of mine.

4.—PUCCINIA PIMPINELLÆ, Strauss.

Pimpinella diversifolia, D. C.

The next æcidium which attracts attention is not so common as those above described, and occurs on *Pimpinella diversifolia.* This parasite may be found in certain localities towards the end of April or the beginning of May, and is very soon after that missed again. Indeed, towards the end of May, it has already become very scarce. The fungus usually attacks the first leaves that are unfolded of this plant, these being simple leaves of the shape of the common violet leaf. The compound leaves later unfolded were very rarely found attacked. The invaded areas of leaves are discoloured, becoming pale yellowish green, and the æcidia are borne almost wholly on the under surface, though a few occasionally break through the upper surface. The æcidial fruit consists of tubular peridia measuring about 2 to 2·25 m.m. in length which burst at their summits in a stellate manner. In addition to the leaf blade, the petiole is not unfrequently attacked, and here the peridial tubes are somewhat longer than they are on the leaf blade. Several distinct patches of æcidia sometimes occur on a single petiole, but in such cases the blade is also largely affected. At these places on the petiole the tissues are somewhat hypertrophied. The leaf blade also where invaded is thickened, the depth of the laminal tissues at such places being about 0·441 m.m., whilst the normal thickness is about 0·239 m.m.

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* Die Pilze Deutschlands, &c. Von Dr. George Winter.

A little later, towards the end of May, when the æcidial parasite is becoming rare, some of the compound leaves (never the simple ones) may be found attacked by a separate mycelium bearing uredospores. This uredospore-bearing mycelium is never found on the same leaf bearing æcidiospores, and it is therefore quite probable that the two mycelia are in no wise genetically related to one another. The uredo-pustules are minute, circular, and saffron-coloured, mostly on the upper surface of the leaf, though by no means infrequently also on the lower. Sometimes the upper surface of a leaf may be seen to be densely covered with these uredo-pustules.

Again in autumn, about the end of September and October, the same plant may be seen largely affected by a puccinia-bearing fungus, a distinct interval having elapsed since the disappearance of all trace of the uredo-bearing fungus. These puccinia-pustules are minute and round, like the uredo-pustules, but black, and occur both on the upper and lower surfaces of the leaves, sometimes in great profusion. The stem is also often affected; the pustules here are linear, their long axes corresponding with the long axis of the stem.

The *æcidiospores* are reddish yellow with very thin walls, the epispore and endospore not being distinguishable from one another: they are round, oval, or somewhat fusiform (Fig. 14, Pl. XII.). The round spores measure 20 to 21 μ in diam., the oval about 32 × 20 μ, and the fusiform about 38 × 14 μ, shortly after being wetted with water.

The *spermogonia* are likewise situated on the under surface of the leaf: they measure about 0·163 m.m. in depth and 0.189 m.m. in breadth. Their mouths are beset with paraphyses projecting about 0.063 m.m. The spermatia are round or oval and measure 4 × 3 μ.

The *peridium* consists of elongated cells, very unlike those of the æcidium on Sanicula described above, measuring about 60 × 20 μ, and easily detached from one another by teasing (Fig. 15, Pl. XII.).

Uredospores.—These are reddish yellow round or oval bodies with coarse tubercles on the surface of the epispore. On an average, the moistened spores measure 22 × 18·3 μ. They germinate readily in water. (Fig. 3, Pl. XII.).

Teleutospores.—These are brown two-celled bodies (puccinia) readily detached from their beds with a very small portion of the stalk remaining adherent to them. In each cell, a clear nuclear body or space may be seen. The epispore is marked externally by fine ridges. They are not thickened at their free ends. As with the uredospores, I never succeeded in getting them to germinate in water. Their measurements are as follows:—whole length of spore 30 μ; length of lower cell 13 μ and of upper cell 17 μ; breadth at septum 23 μ; extreme breadth of upper cell 24 μ and of lower cell 22 μ.

Remarks.—At first it seemed extremely probable that all the three forms above described were phases of one fungus, and I attempted frequently to establish a relationship between them by experiment, but always without success. This alone, however, does not justify me in definitely denying a relationship between them, since it is quite possible that some condition of my experiments militated against the manifestation of a relationship. However, the experiments were carefully conducted and often repeated. I also attempted to reproduce the æcidium by laying the teleutospores found on several grasses in the neighbourhood on the young leaves; but in these attempts also I failed.

This parasite is probably identical with *Puccinia Pimpinellæ*, Strauss, in which the æcidiospores are said to measure 18 to 35 μ long and 16 to 21 μ broad (average 26·5 × 18·5 μ), the uredospores, 23—32 μ long and 19 to 24 μ broad (average 27·5 × 21·5), and the teleutospores, 26 to 35 μ long and 17 to 26 μ broad (average, 30·5 × 21·5). The only feature in which this fungus differs from that which I have described is in the characters and size of the uredospores. In Strauss's plant the uredospores are said to be pale brown, while in mine they are reddish yellow and smaller.

5.—PUCCINIA CORONATA, Corda?

Rhamnus dahuricus, Pall.

The Æcidium which occurs on this plant is not very common, although occasionally an attacked tree or bush is very extensively affected. The fully ripe æcidium may be found as early as the latter part of May, but it is more usually met with about the middle of July. The fungus attacks leaves, young stem (Figs. 1, 2, 3, Pl. XIII.), and drupes, the last sometimes very extensively indeed. When the leaf is attacked, the invaded areas are usually small, and generally only one patch occurs on each leaf. These patches are dark reddish brown above, surrounded by a halo of pale yellow (Fig. 2, Pl. XIII.), and the orange-yellow æcidia are borne on the lower or concave surface of the leaf, opposite the dark central part seen above (Fig. 1, Pl. XIII). The red colour of the patch is due especially to discoloration in the palisade cells, and the abnormal thickness to hypertrophy of the spongy tissue, the palisade cells retaining their normal dimensions and characters. The tissues in the areas invaded are very extensively permeated by hyphæ, and many cells are destroyed. While the thickness of the leaf blade is normally 0·126 m.m., it is about 0·440 m.m. in patches bearing ripe æcidia. A patch of ordinary size measured 1 c.m. in total diameter, the central reddish brown part measuring 6 m.m. in diameter. The patches are sometimes considerably larger, however, and more irregular in shape. The æcidia are tubular structures, very deeply sunk into the laminal tissue, measuring about 1·75 m.m. in length, and therefore resembling in some degree the Æcidium on *Pyrus variolosa* described below. With very few exceptions, the æcidia burst from the lower surface of the leaf. These patches on the leaves are often placed near the margin of the leaf, and are usually between and not over the principal veins; but when a vein is involved it is considerably thickened. When the stem is attacked, which occurs but rarely, it is considerably swollen. The drupes when attacked are often densely covered with æcidial tubes, set at right angles, all over them.

The *spermogonia* are formed on both the upper and lower surfaces of the patches, and may often be found ripe when the æcidia on the same patches are also fully developed. They are inserted between the cells of the single layer of palisade cells when situated on the upper surface. They have a tuft of paraphyses protruding through their mouths, and measure about 0·107 m.m. in depth and breadth.

The *æcidiospores* are round orange-yellow bodies of very uniform size measuring 23 μ in diameter when recently wetted with water (Fig. 5, Pl. XIII.). The *peridial* cells are roughly hexagonal, adhere very firmly to one another, and measure about 26 × 16 μ. The centre of each cell contains orange-yellow matter like the contents of the æcidiospores (Fig. 4, Pl. XIII.).

Remarks.—There can be little doubt that this Æcidium is caused by a Puccinia, with all the characters of *Puccinia coronata*, which occurs on *Brachypodium sylvaticum* in Simla, but unfortunately I have not had sufficient opportunities of verifying this. So far as my insufficient experiments go, I have always obtained negative results. I am also not quite sure whether this Æcidium does not also occur on *Sageretia oppositifolia.*

6.—PUCCINIA FRAGARIÆ, nov. sp.

Fragaria vesca, Linn.

During May, and just before it flowers, the Wild Strawberry, *Fragaria vesca,* may in some years be seen attacked by an æcidial fungus. This parasite is, however, a rare one, and I found it on two occasions only in 1885 at localities distant a few miles from one another, and on each occasion only a single affected plant was found. Æcidial fructification was found both on the petiole and on the leaf blade. It is somewhat curious that the same leaf bore *simultaneously* uredo and teleutospore pustules, but all the three forms of spore-pustules were quite distinct from one another, with green normal tissue between them—at least, I could not trace any mycelial connection between them. The æcidial fructification consists of groups of æcidia on the margins of the leaves. The portions of the leaf blade bearing these quickly wither and dry up after the æcidia ripen. The æcidia break through both the upper and lower surfaces of the leaf, but more frequently from the lower. Spermogonia of the usual form are frequently present, especially on the petiole when this is affected, and they are placed usually close by the side of the æcidia.

The *æcidiospores* are pale yellow and very irregular in size and shape, varying from round to oval, often faceted and irregularly angular. Their average measurements when moistened are 22 × 15·8 μ. The epispore is finely punctated (Fig. 6, Pl. XIII.). Placed in a decoction of cow-dung (Brefeld) several in 24 hours threw out short germinal tubes of an average diameter of 5·3 μ, but the greater number of spores would not germinate.

The *uredospores* are oval or pear-shaped and pale yellow in colour (Fig. 7, Pl. XIII.). They are produced in little circular yellow pustules, which are situated on both surfaces of the leaf. The external surface of the epispore is beset with prominent tubercles. The moistened spores measured on an average 21 × 17 μ. Placed in a decoction of cow-dung, only two were found to have germinated on the 5th day, whilst those placed in water did not germinate at all (Fig. 8, Pl. XIII.). The *teleutospores* are contained in little black pustules situated close to the æcidial fructifications. They were produced on both the upper and lower surfaces of the leaf blade, but more frequently on the lower surface, as in the case of the æcidia. The spores are dark brown, two-celled bodies, puccinia, easily detached from their beds, breaking off with only a small fragment of stalk adhering (Fig. 9, Pl. XIII.). The average measurements of these spores when moistened were as follows:—whole length 31·7 μ; length of upper cell 15·8 μ, and breadth of same 22·4 μ; length of lower cell 15·8, and width of same 21 μ. The stalks bearing these spores are from 2 to 2½ times the whole length of the spore. Amongst these teleutospores a few uredospores occurred of the characters above given. The teleutospores were sown in a decoction of cow-dung, as well as in water, but they did not germinate. On one occasion, in autumn (November), I found a single leaf of this plant plentifully covered with teleutospore-pustules. I did not succeed in getting them to germinate.

From want of sufficient material, I could not experimentally determine a genetic relationship between these different spores, but the close proximity of the teleutosporic sori to the æcidial fructification and the occurrence of uredospores in the teleutospore-pustules lend some support to the view that we have here to do with a complete autoecious Uredine. However, in the absence of experimental evidence, this remains a mere presumption.

Remarks.—I believe that this is an entirely new species, and I have therefore named it *Puccinia Fragariæ*, in accordance with recognised precedent in nomenclature, although I should have preferred naming it *Æcidium Fragariæ.*

7.—ÆCIDIUM LEUCOSPERMUM, D. C.?

Anemone rivularis, Ham.

This fungus is remarkably localised. During the last three years, although I have looked for it everywhere about Simla, and the host may be found everywhere, I have found it in only two localities, one in Simla (Annandale), the other in a forest (Cheog) about 14 miles distant. In these localities I have found it in June, July, and the beginning of August, before the plant flowers. The most striking peculiarity of this æcidium is that it is white. The whole leaf is often involved, though generally only well-defined portions are, and frequently the margin of the leaf (Fig. 11, Pl. XIII.). The æcidia break out almost entirely from the under surface, though a few may occasionally be seen on the upper surface. When a young immature leaf is attacked, as is often the case, there is a striking arrest of growth, the leaf never attaining the usual size shown by sister leaves of the same plant which are not affected—indeed, a fully affected young leaf is often only one quarter the normal size. The petioles were never seen to be attacked. Sometimes every leaf of a plant was found attacked. The attacked areas after the ripening of the æcidia quickly turn brown and wither.

The *æcidiospores*, when just wetted, are round or oval and measure on an average 17·7 × 15·6 μ. The epispore is beset with very minute tubercles (Fig. 12, Pl. XIII). I never succeeded in getting them to germinate in a growing cell. The peridial cells measure about 18 × 16 μ.

The *spermogonia*, formed only on the upper surface of the leaf, measure about 80 μ in depth and 120 μ in breadth. They are very superficially situated, having their bases sunk only through the epidermis and resting on the palisade cells. A tuft of paraphyses projects through their mouths about 40 to 50 μ in length.

Remarks.—Puccinia Anemones, Pers., occurs on *A. nemorosa* and *A. ranunculoides*, forming powdery masses of teleutospores (without uredospores) on the under surfaces of the leaves. Each of these hosts also bears an Æcidium, that on *A. ranunculoides* (*Æc. punctatum*, Pers.) having violet-brown æcidiospores and that on *A. nemorosa*

(*Æc. leucospermum*, D. C.) having white spores. Although I have carefully searched for teleutospores on *A. rivularis* in Simla, I have never found them, and I am therefore constrained to call this Æcidium *Æc. leucospermum* in the meantime. Schröter, I understand, thinks the teleutospores on *A. nemorosa* are related to the Æcidium borne on the same host, whilst Fuckel relates the Æcidium on *A. ranunculoides* with the teleutospores borne on it. The Himalayan Æcidium would appear to throw some doubt on the connection between their teleutospores (*Puccinia fusca*, Relhan) and the two æcidia, or, at any rate, if that be indisputable, the Himalayan Æcidium must be entirely different, being most probably a heteroecious Uredine.

8.—Æcidium Thalictri flavi, D. C.?

Thalictrum Javanicum, Blume.

The Æcidium on this plant, as in the case of that just described on Anemone, is remarkably localised, although the host is widely diffused. It is therefore a rare parasite, although, in the localities in which it is found, it occurs abundantly enough. It is met with during the rains, in July, while the plant is flowering. Only the leaf blades are as a rule affected, but occasionally the petiole is also attacked, when it is considerably hypertrophied and distorted. Fig. 1, Pl. XIV. represents the petiole attacked in two places: in both cases it will be seen that the petiole has become considerably elongated and in one case also bent completely round through 360°. When the parasite attacks the leaf blades, little reddish yellow spots are formed as seen from above, measuring ordinarily from a minute point to 4 or 5 m.m. in diameter. Sometimes, however, the patches are much larger—in one case 1 c. m. in diameter—and then the leaf is considerably distorted, especially when a main vein is involved. These larger patches are reddish brown above. The attacked areas are generally convex above at first, but often, as the area becomes larger, the converse obtains. The patches are frequently placed over a prominent vein, which is then, within the affected area, considerably swollen. The number of patches on a single leaflet varies from one to twelve or perhaps more. These attacked areas on the leaf blade are considerably thickened: the normal thickness of these delicate leaves is 0·095, m.m., whilst near a young still immature æcidium it was found to be 0·410 m.m.

Spermogonia are formed abundantly both on the upper and lower surfaces, and to the naked eye appear as minute pellucid reddish yellow spots. They are of the usual structure, measuring about 63 to 80 μ in depth and 75 to 94 μ in width. These structures are well sunk into the leaf tissue. Their mouths are surmounted by a tuft of paraphyses about 60 to 65 μ in length. The tissues of the leaf are not so greatly hypertrophied in the spermogonial stage as they afterwards become, the depth of the laminal tissues near a ripe spermogonium being 0·189 m.m. in one case.

The *peridium* (Fig. 13, Pl. XIII) consists of a single layer of angular flattened cells measuring from 31·5 or 37·8 μ in length by 16 to 31 μ in breadth, or on an average 33·6 × 23·21 μ, shortly after immersion in water. It opens stellately. The *æcidiospores* are oval or round (Fig. 14, Pl. XIII.) reddish yellow bodies with a smooth epispore. The contents are either homogeneous or granular, more usually the latter. When just wetted, they measure about 25 μ in diameter, and the epispore is about 1·5 μ to 2 μ in thickness. They are given off serially as usual from basidia, but there are intermediate cells between succeeding spores (Fig. 15, Pl. XIII.).

Remarks.—It may not be out of place here to refer to a very fine Æcidium on *Thalictrum minus*, Linn., which I found on the 7th May 1884 at Urni, a village on the Hindustan-Thibet road about 126 miles from Simla towards the "Interior." It is quite possible that this is the same species as that which I have just described as found in Simla, but it gives rise to very considerably greater distortions and hypertrophies in its host. The attacked plants were indeed extremely distorted: sometimes a whole flower head exhibited a mass of small æcidial tubes (Fig. 16, Pl. XV.), and individual leaflets when largely invaded exhibited the most curious forms (Fig. 17, Pl. XV.). In this form, sometimes, though not very frequently, the stalk also was affected. The æcidiospores are orange-yellow, and measured, when dry, 19 × 16 μ on an average, but, when well moistened, 22 × 18 μ.

It is possible that both these forms are identical with, or varieties of, *Æcidium Thalictri flavi*, D. C., the æcidiospores of which are said to measure 17 to 28 μ long and 14 to 20 μ broad.

9.—ÆCIDIUM JASMINI, nov. sp.

Jasminum humile, Linn.

An Æcidium may be found on this plant during July and August, but is decidedly uncommon. The parasite attacks both leaf and petiole, but more commonly the leaf blade, giving rise to an irregularly circular patch, slightly paled above, greenish yellow and brownish red below. These patches vary in size, but are usually about 8 m.m. to 1 c. m. in diameter. The involved areas of the leaf are slightly thickened. The æcidia burst out exclusively from the under surface of the leaf, so far as my observations extend. They contain brilliant orange-yellow spores, the peridium, a short tubular structure, bursting at the summit in a stellate manner. Spermogonia exist only on the upper surface, preceding the appearance of the æcidia by a very short time—indeed, while ripe spermogonia exist on the upper surface of a patch, young unopened æcidia may also be found on the lower surface of the same patch.

The *mycelium*, which ramifies between the parenchyma cells, is colourless. The bases of the spermogonia extend to the inner level of the palisade cells, and the bases of the æcidia from the other side reach down to the same point. The spermogonia measure about 126 μ in depth and 157 μ in breadth, and have a tuft of paraphyses projecting from the mouth to about 63 μ.

The *peridium* consists of a single layer of flat cells, more or less hexagonal and measuring about 26 × 22 μ (Fig. 2, Pl. XIV.). These cells are thick-walled and contain some yellow oil globules in their cavities.

The *æcidiospores*, after lying a few minutes in water, measured 26·2 × 20·2 μ on an average. Their contents are of a brilliant orange-yellow colour, and they have a thin epispore without any markings (Fig. 3, Pl. XIV.). I did not succeed in observing their germination, as they steadily refused to grow in water. The only other species of Jasmine common in Simla is *J. officinale*, L., but this host nevers bears an Æcidium, although the closely related *J. grandiflorum*, L., which grows at considerably lower elevations, harbours a very distinct and peculiar one, which I hope to describe later.

10.—MONOSPORIDIUM EUPHORBIÆ, gen. et sp. nov.

Euphorbia cognata, Klotzsch.

Towards the end of July and during the first half of August, a very peculiar Æcidium on this plant presenting some very unusual characters is not uncommon; and some individual plants are very extensively attacked. Only the leaf blades are attacked, so far as I have observed, and a single leaf may exhibit from one to six patches of invasion. These patches are circular and rosy red above with a broad and irregular halo of paled yellowish tissue around them, the paling increasing in area as the patch grows older (Fig. 4, Pl. XIV.). On the under surface the patch is quite white and cushion like (convex). When very young, this cushion on the lower surface of the leaf is uniformly convex, and with a field lens a few pellucid spots may be seen in its centre, which are spermogonia. Later, as the spermogonia wither, a very distinct pit or depression is formed in the centre of the cushion, and, while this central pit enlarges in area, so the circular cushion surrounding it becomes more and more prominent and whiter. At last the central pit is very distinct with now *black* points, the dried up spermogonia, over it (Fig. 4, Pl. XIV), and then the epidermis covering the surrounding cushion tears circularly near the external margin of the cushion and curls up inwards towards the centre disclosing a bed of white æcidiospores (*see* left-hand patch in Fig. 4, *a.* and *b.*). The *spermogonia*, which are extremely superficially placed (*see* Fig. 6, Pl. XIV.), are thus situated on the under surface of the leaf only. They are of the usual form and structure with a tuft of paraphyses protruding through the mouth. The whole organ, excluding the paraphyses, measures about 50 μ in depth and 100 μ in breadth. The *æcidiospores*, when just wetted with water, measure from 22 × 20 μ to 19 × 18 μ, the average of several measurements being 21 × 19·2 μ. The spores are colourless and almost round (Fig. 5, *a.* Pl. XIV.) with an epispore densely studded with minute tubercles. The distribution of the *mycelium* is peculiar and deserves description. In a section of a leaf passing through the æcidium, it will be seen that the mycelium lies mainly in two strands, one under the upper epidermis, between it and the palisade-cells, the other and larger under the lower epidermis, between it and the spongy cells (Fig. 6, Pl. XIV.). Moreover, the character of the layer of hyphæ under the upper epidermis is of a somewhat looser, more pseudo-parenchymatous character, than that under the lower epidermis (Fig. 7, Pl. XIV.). It should be noted that these layers of mycelial filaments are composed solely of hyphæ without any part of the host tissue being involved within them, and thus resemble strikingly the non-algal parts of lichens. The palisade-cells and spongy tissue between the two layers of mycelium are indeed extremely little affected or altered in any way. While in unaffected normal places the length of the palisade-cells is about 60 μ, and the depth of the spongy tissue layer about 50 μ, these measurements within attacked areas are about 56 μ and 36 μ, thus showing some diminution in size, especially in the spongy layer. The lower mycelial layer is about 50 μ in depth and the upper layer only 24 μ. The æcidial fructification is, as it were, inserted within the lower mycelial layer (*see* Fig. 6, Pl. XIV.), some strands passing above it and some below it. The *peridium* consists of a layer of cells about 32 × 30 μ in size, forming only a *roof* to the extremely large circular æcidium (*see* Fig. 6, Pl. XIV.). These cells are very loosely attached to one another, readily becoming isolated. Such an isolated cell is shown in Fig. 5, *b.* Pl. XIV; and this figure also shows that it is beset externally with tubercles. The æcidiospores are given off in rows from a pseudo-parenchymatous hymenium without any well defined basidia, and have no intermediate cells between successive spores (Fig. 6, Pl. XIV.). The æcidiospores, as seen in rows in sections of leaves that have been hardened in absolute alcohol, are cubical (Fig. 6, Pl. XIV.).

The germination of these æcidiospores is very peculiar and unlike that of any other species with which I am acquainted, with the single exception of the æcidiospores of the Æcidium on another Euphorbiaceous plant *(Andrachne cordifolia)* described further on. I have not here, unfortunately, access to special memoirs on the development of individual Uredines, so that I am unable to state definitely that the mode of germination of these spores is altogether unknown, but, so far as I have been able to consult the works of others on this subject, I have not seen this mode described. The spores germinate fairly readily in water, throwing out the usual single germ-tube, measuring 5 μ in diameter (Fig. 7, Pl. XV.). After a time, from 24 to 48 hours, a secondary spore (sporidium ?) is formed at the end of the germ-tube, not upon any sterigma, but simply separated from the tube by a septum (Fig. 9, Pl. XV.). This secondary spore is round or oval, is double-contoured, and contains well defined granules in a mass of protoplasm (Fig. 9, Pl. XV.). They measure as a rule 14 μ in diameter. The day after the formation of this secondary spore, it germinates while still attached to the primary germ-tube, throwing out a secondary germ-tube which soon takes on a spiral form (Fig. 8, Pl. XV.). After this, the whole structure perishes, and I have not been able to determine its future history.

Remarks.—This Æcidium is evidently not *Æc. Euphorbiæ*, Gmelin, (or *Uromyces Pisi*, Pers.), as in this species the mycelium is described as pervading the whole plant or shoot, deforming all the leaves and preventing the formation of flowers on the shoots attacked. In the Æcidium above described, only local and well-defined areas of the leaves are attacked by the mycelium; the leaves are not altered in general shape, and the shoots bear flowers as usual. For much the same reasons this Æcidium is not *Uromyces scutellatus*, Lév., which also markedly deforms the leaves. It remains to consider its affinities with the genus Endophyllum and especially with *E. Euphorbiæ silvaticæ*, D. C., on *Euphorbia amygdaloides*, which is said to cause a well defined alteration in the leaves of the host, rendering them shorter and wider and somewhat fleshy, and discolouring them to a pale yellowish green colour. Moreover, this parasite has orange-yellow spores 16 to 26 μ long and 12 to 18 μ wide, whilst in the Simla Æcidium the spores are colourless or pale brownish and measure, as stated above, 22 × 20 μ to 19 × 18 μ. Moreover, the germination of the æcidiospores of the last mentioned Æcidium is different from that described in the case of Endophyllum, which is essentially of the nature of the germination of teleutospores. There is, however, some resemblance between the two Æcidia in this respect, for we may consider the secondary spore of the

Simla Æcidium to be of the nature of a sporidium, and then the only difference that exists between them is that, whilst in Endophyllum four deciduous sporidia are formed on sterigmata, in the Simla parasite only one non-deciduous one is produced directly at the end of the promycelium instead of at the end of a sterigma. But these differences are still great enough, I think, to entitle the species to be regarded as the type of a very distinct group of the Æcidiomycetes having its closest affinities with the genus Endophyllum. The only other Æcidium with which I am acquainted that would find a place in this new group or genus would be that which I have described further on on *Andrachne cordifolia.* I would define the characters of this new (provisional) genus as follows :—

Monosporidium, gen. nov.

Spore layer very like, or identically the same as, that of the Æcidia of Puccinia and Uromyces. The spores are abstricted in rows, but behave in germination somewhat like teleutospores in that the germ tube (promycelium ?) produces a secondary non-deciduous spore (sporidium ?) directly at its extremity without the intervention of a sterigma.

11.—Puccinia Graminis, Pers.

Berberis aristata, D.C.

During August, the Barberry may frequently be found attacked by an æcidium-bearing parasite. Only the leaves are attacked, and, on them, circular patches are formed, almost crimson-red on the upper surface with a narrow halo of pale yellow-green (Fig. 3, Pl. XV) and pale rosy red below with pale yellow æcidia thickly strewn over it. A single leaf may contain from one to six or eight such patches. A medium-sized patch measures from 4 to 5 m.m. in diameter (including the halo of yellow), but sometimes the patches exceed 1 c. m. in diameter. With a field lens, numerous spermogonia may be seen on the upper red surface, but also a few in the centre of the lower surface, around which the æcidia are arranged.

The *æcidiospores,* when just moistened, measure from 22 × 17 μ to 20 × 18 μ, or, on an average, 20·8 × 17·8 μ. The contents are bright orange-yellow, and usually on one side of the spore a colourless space is left filled apparently with colourless protoplasm (Fig. 8, Pl. XIV) giving a characteristic appearance to the spores. The peridial cells are generally square in outline and measure about 20 × 18 μ (*see* Fig. 9, Pl. XIV.). They are thick-walled, thicker on one side (Fig. 10, Pl. XIV.), and contain orange-yellow matter in their centres.

When invaded by mycelium, the leaf is generally considerably thickened, and the cells of the host are filled densely with starch grains. The *spermogonia* are situated mostly on the upper surface of the leaf, though some are borne also on the under surface. They are of the usual structure, well sunk into the tissue of the host, and with a tuft of paraphyses protruding from their mouths. These organs generally measure about 0·198 to 0·151 m.m. in depth and 0·138 to 0.126 m.m. in width, the tuft of paraphyses measuring about 75 μ in length.

Remarks.—There can be no doubt, I think, that this is identical with *Puccinia Graminis* as described by De Bary, although I have not confirmed its genetic relationship with the Puccinia on cereals which occurs very abundantly in all the fields around Simla. I am also not quite certain that all the three forms of Berberis which occur in Simla (namely, *B. vulgaris*, L., and *B. Lycium*, Roylé, in addition to that already mentioned) bear the same species of Æcidium. The subject is one which requires further investigation and I will therefore leave it at present an open question.

12.—ÆCIDIUM URTICÆ, Schum., var. HIMALAYENSE.

Urtica parviflora, Roxb.

I have described the life-history of this remarkable and very common Æcidium elsewhere,* so it is only necessary here to state briefly its characters. The parasite gives rise to remarkable hypertrophies of the tissues of the host invaded, usually the leaves and petioles, though frequently also the stems. When attacking the leaves, it has a special proneness to invade the main veins; and, by causing very great hypertrophy in them, gives rise to remarkable contortions. When it attacks the stem, it usually produces well defined comparatively large tumours or excrescences. The parasite is usually found in its fullest development during July. The hypertrophy of the parts invaded is due mainly to the increased size of the parenchyma cells, which are stored with nutritive material, and, to a very subordinate extent, to mycelial invasion. The mycelium penetrates some of the parenchyma cells forming haustoria of the branched type.

The *spermogonia* measure about 0·178 m.m. in depth and breadth with a tuft of paraphyses 68 μ long.

The æcidiospores are contained in a *peridium* of a single layer of flattened polygonal cells measuring on an average 20 μ in diameter. The *æcidiospores* are given off in long rows from basidia arranged very regularly on a level base. They are yellow round bodies with finely granular contents and beset externally with minute deciduous tubercles. The moistened spore measures on an average 15·6 × 13·1 μ. The life-history of this æcidium is completed on *Carex setigera*, Don. The uredospores on this second host measure from 19·8 × 13·5 μ to 19·2 × 12·8 μ. The teleutospores (puccinia) are 56 μ long by 15 μ broad on an average. The upper cell measures 24 to 20 μ in length by 12 to 17 μ in breadth, whilst the lower cell varies from 20 to 14 μ in length and 12 to 14 μ in breadth. In germinating, each cell forms a promycelium which divides at its end into four compartments each forming a sporidium at the end of a slender sterigma. The sporidia measure 12 × 8 μ. For further particulars I must refer to the paper already alluded to.

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* "Scientific Memoirs by Medical Officers of the Army of India," Part II. Calcutta, 1887.

13.—ÆCIDIUM STROBILANTHIS, Barclay.

Strobilanthes Dalhousianus, Clarke.

The Æcidium which occurs on this plant is probably the most common and widely diffused in Simla. I have described its life-history fully in a paper in "Scientific Memoirs by the Medical Officers of the Army of India"*, to which I would refer those who desire further information, while here I will only note its main characters. The parasite may be found abundantly during July and August attacking only the leaf-blades and very rarely indeed the petiole. The leaves are often found very extensively bespattered with circular discoloured patches, yellow or yellowish green above and rosy or purplish or yellow below. The patches usually measure about 4—5 m.m. in diameter, but sometimes more, and are usually slightly concave above. The spermogonia are borne on the upper surface and may be recognised as minute points. The æcidia are borne on the lower surface. The invaded areas are considerably thickened, the thickening being due mostly to hypertrophy of the spongy cells and to a lesser extent to that of the palisade-cells. The mycelial filaments are of the usual characters and form here and there simple tubular haustoria.

The *peridium* consists of a single layer of flattened angular cells measuring on an average 16·3 × 11·6 μ. The *æcidiospores* are given off in rows, as usual, without intermediate cells. They are irregularly round pale orange-yellow and measure, when just moistened, 18 × 16 μ.

The *spermogonia* measure about 100 μ in depth by 94 μ in width. They are formed both on the upper and on the lower surface of the leaf, but more frequently on the upper. They have a tuft of paraphyses protruding through their mouths about 80—90 μ.

This fungus completes its cycle of development on *Pollinia nuda*,

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* "Scientific Memoirs by the Medical Officers of the Army of India," Part II. Calcutta, 1887.

Trin. The uredospores on this last mentioned host measure, when just wetted, 21·6 × 20·2 μ. The teleutospores (puccinia) on the same measure 36 μ in length by 16 μ at the septum. The septum divides the spore into two equal halves. The promycelia from each cell divide at their ends into four cells, each of which produces a sporidium at the end of a slender sterigma. The sporidia measure from 10 × 6 μ to 12 × 7 μ.

14.—GYMNOSPORANGIUM CLAVARIÆFORME, Jacq.?

Pyrus variolosa, Wall.

An Æcidium (Roestelia) on this single species of the several members of the Pomaceæ in and about Simla is fairly common from May to August: but I have observed in this case, as in several others, that in some years it is more common than in others. For example, in 1885, I found no difficulty in obtaining as many specimens as I desired: in 1886, I experienced the greatest difficulty in finding a very few, while now, in 1887, it is again fairly common, though not so common as in 1885. It attacks only the leaf-blades and no other parts, so far as my observations have extended, forming well defined patches, orange-red above and yellowish below, the upper surface being densely studded with spermogonia. Generally the fully developed older dark green leaves bear these æcidial patches, the younger paler leaves being only exceptionally attacked and these late in the season, namely, in July, The area of the leaf blade invaded varies in extent from a few millimeters in diameter to 1 c. m. or even a little more, and is considerably thickened. While the thickness of the normal leaf blade is about 0·170 to 0·190 m.m., the attacked parts when æcidia are developed measure about 0·880 m.m. The thickening of the leaf blade is due mostly to an apparent proliferation of the spongy tissue cells, which are also altered in form, becoming long palisade-like cells instead of irregularly round as under normal conditions. The true normal palisade-cells are about 44 μ in length, whilst the transformed spongy cells are 63 to 107 μ in length. The mycelium ramifies throughout the cells of the attacked areas.

The æcidia are very deeply sunk, long tubular structures, the portion sunken beneath the level of the epidermis being about 0·756 m.m. in length and about 0·190 m.m. in diameter. Each æcidium is situated on a minute papilla and is extruded only from the under surface of the leaf, never from the upper. That portion of the æcidial fruit which projects freely beyond the level of the epidermis is about 1 to 2 m.m. in length.

The *peridium* consists of a single layer of cells, the lower ones being more elongated than the upper. Those situated about the middle measure about 70 × 22 μ, and all are beset with prominent rod-like excrescences (Fig. 5, Pl. XV.). When the æcidium is ripe, the peridium bursts longitudinally in strips from summit to base.

The *æcidiospores* are round or oftener oval, measuring, when just wetted, 28·6 × 24·6 μ on an average. They are pale brown in colour and their surfaces are beset with minute tubercles (Fig. 6, Pl. XV.).

The *spermogonia* are formed only on the upper surface of the leaf, and when ripe have a sticky clear fluid over them probably secreted by the tuft of paraphyses, which, arising from the very base of the organ, project considerably (about 50 to 60 μ,) from the mouths. They are well sunken into the tissue of the leaf, their bases pushing down and disintegrating the palisade-cells. They remain covered over by the cuticle until ripe, when the cuticle is raised and opened by a porous opening. The formation of the spermogonia precedes that of the æcidia by a very considerable length of time. In the spermogonial stage, the hypertrophy of the leaf tissue is not so great as it becomes later, the thickness of the lamina being about 0·41 m.m. If sections of the leaf through a spermogonium be stained with Spiller's purple, it will be found that, while the sterigmata are coloured blue, the spermatia are coloured brick-red. The spermatia are oval and measure 8 × 4 μ.

Remarks.—From the nature of the dehiscence of the peridium, there can be no doubt that this Æcidium is identical with or allied to *Gymnosporangium clavariæforme*, Jacq., though in some respects it is not unlike *G. juniperinum*, L., especially in the colour of the spores. I made very frequent and numerous attempts to reproduce this Æcidium with teleutospores from a Gymnosporangium on *Cupressus torulosa* which is by no means uncommon on the few trees which occur in Simla, but always without result. Notwithstanding these negative results, I am still, however, inclined to believe that this Gymnosporangium (the only one I am acquainted with in these parts) is genetically related to the Æcidium just described, and I attribute my negative results to the influence of some unknown condition attending my experiments, although I have varied the conditions in every conceivable manner.

15.—MONOSPORIDIUM ANDRACHNIS, gen. et. sp. nov.

Andrachne cordifolia, Müll. Arg.

During August, especially towards its latter end, an Æcidium is not unfrequently met with on this host, which is common at elevations a little below that of Simla. It is not, however, a common Æcidium. Only the leaves are attacked and on them circular patches are formed by the fungus, red above with an irregular halo of yellow around it (Fig. 2, Pl. XV) and pale rosy red beneath (Fig. 1, Pl. XV.). The patch is concave on the upper or red surface, the under surface being correspondingly convex, and on this latter surface only are the Æcidia produced. Generally only one patch is to be found on a single leaf, though I have seen as many as six. The patches are usually very uniform in size, generally measuring about 6 m.m. in a diameter. The centre of the under surface of the patch is occupied by a number of spermogonia, while around it the æcidia are grouped more or less irregularly. A few spermogonia, however, emerge from the upper surface also. This Æcidium, therefore, in its general characters already resembles that described above on *Euphorbia cognata*, but differs notably in the æcidia being isolated cups, whilst in Euphubia we may imagine that the several cups have all fused together into one large circular æcidial fruit. The peculiar arrangement of the mycelium, however, in layers so characteristic of *M. Euphorbiae* is not found here. The mycelium ramifies generally among the cells as in other æcidia. The palisade-cells are not disarranged or deformed in any way, but the spongy tissue cells are hypertrophied and proliferated. The thickness of the leaf where invaded and where ripe aecidia were borne was in one instance 0·334 m.m., whilst the normal thickness was 0·138 m.m. The spermogonia are very small and superficial, as in *M. Euphorbiae.* They are insinuated between the epidermis cells and measure about 44 μ in width and 25 to 30 μ in depth. The æcidia when fully ripe measure about 0·265 to 0·248 m.m. in width and 0·233 to 0·217 m.m. in depth.

The *æcidiospores* are round, oval (Fig. 11, Pl. XV.), colourless, or very pale brown, and measure, when just wetted, on an average 21·6 × 18·4 μ, varying from 20 × 16 to 24 × 20 μ. They are given off in rows without any intermediate cells. The peridial cells are flat and irregular in shape, imbricate in arrangement, and measure from 18 to 24 μ in diameter (Fig. 10, Pl. XV.). They are beset with small ridges or tubercles. The mode of germination of these æcidiospores is exactly like the peculiar germination of the spores of *Monosporidium Euphorbiae.* The spores germinate very readily in water, throwing out a long non-septate tube, when the empty spore wall is seen to be beset very densely with minute tubercles. After lying in water 24 to 36 hours, a secondary spore is formed at the extremity of the germ tube (Fig. 13, Pl. XV.) just as I have described it in the case of Euphorbia. This secondary spore or sporidium is separated off from the germ tube by a septum, but never falls off altogether from the tube. In a cultivation of 48 hours' duration, I saw numerous secondary spores, and several of them, while still attached, had commenced to germinate, throwing out narrow tubes, which, though twisted a little (Fig. 14, Pl. XV.), never became spiral as in the case of *M. Euphorbiae*, nor so long. These secondary spores measure from 18 × 15 μ to 22 × 16 μ and on an average 20·3 × 15 μ. They are double-contoured and contain large granules in their protoplasm.

16.—ÆCIDIUM COMPOSITARUM, Martins.

Myriactis nepalensis, Less.

I have never found this Æcidium actually in Simla, where the host is common, but at Mashobra, a few miles beyond the Station, at about the same elevation. It may be found there towards the end of August and beginning of September. Only the lower leaves are affected, and generally before the plant sends up its flowering stalk, though I found one plant with three of its lower leaves affected while it was in full flower. The patches are circular and usually single, but sometimes more, on each leaf, and they are very large, measuring about 1·5 c. m. in diameter. The upper surface is pale yellow with a dark discoloured centre as the patch becomes older, while the lower surface is very pale yellow and here the æcidia are borne in great numbers thickly set together. With a field-lens it may be seen that the spermogonia are borne on the upper surface quite on the *margin* of the patch and not within it.

The *æcidiospores* are irregularly round or oval, pale yellow, and, when just wetted, measure from 14 × 14 to 17 × 12 μ and on an average 16 × 15·2 μ. (Fig. 15, *a.*, *b.*, Pl. XV.). The spores are given off in rows as usual. The epispore is thin.

The peridial cells measure about 34 × 16 μ to 42 × 20 μ and are arranged in an imbricate manner (Fig. 15, *c.*, *d.*, Pl. XV.).

Remarks.—The Æcidium not occurring actually in Simla, so far as I am aware, I have not been able to pay special attention to it. I presume it may be included under *Æcidium Compositarum*, Martins, although the measurements I give of the æcidiospores are smaller than those given by Winter in the case of *Puccinia flosculosorum*, Alb. & Schw., and *Uromyces Junci*, Desmaz. However, as I do not know of any teleutospore belonging to this Æcidium, I cannot do better than refer it provisionally to *A. Compositarum*, as recommended by Winter.

Concluding Remarks.—This completes the list of æcidium-bearing Uredines I have hitherto been able to examine in Simla, with the exception of the five which occur in Coniferæ, and which I hope to describe in a future paper. Three of these (on *Abies Smithiana* and *Cedrus Deodara*) I have already described in this Journal.* The other two occur on *Pinus longifolia* and *P. excelsa.*

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* J. A. S. B. 1886, vol lv, pt. ii, pp. 1—11, pls. i—iii; pp. 140–143, pls. iii, iv; et pp. 223—226, pls. vi, vii.

In addition to these, I have seen Æcidia on a species of *Geranium* (probably *nepalense*) and on *Ranunculus diffusus*, but in each case I only once found specimens, and unfortunately in each case I was unable to examine them. They are extremely rare about Simla. I may here also note that a very interesting Æcidium occurs on *Jasminum grandiflorum*, L., whose life history I am now engaged in investigating, but it is confined to the low-lying valleys near Simla and never appears in the station, which is too high for the host. A nearly allied species (*Jasminum officinale*, L.) which occurs abundantly in the woods about Simla never harbours this parasite or that which I have described above on *Jasminum humile*.

DESCRIPTION OF THE PLATES.

Plate XII.

1.	Sanicula	æcidiospore, × 350.
2.	Ditto	peridial cells, × 350.
3.	Pimpinella	uredospore, × 350.
4.	Violet	leaf, lower surface, natural size.
5.	Ditto	leaf, upper surface, natural size.
6.	Ditto	æcidiospore, 24 hours in water, × 250.
7.	Ditto	promycelium, × 350.
8.	Ditto	ditto.
9.	Ditto	ditto: showing terminal sporidial formation, × 350.
10.	Ditto	germinating sporidium, × 350.
11.	Ditto	peridial cells, × 400.
12.	Valeriana	æcidiospore, × 580.
13.	Ditto	uromyces spore, × 580.
14.	Pimpinella	æcidiospore, × 350.
15.	Ditto	peridial cells, × 350.

Plate XIII.

1.	Rhamnus :	leaf, lower surface, natural size.
2.	Ditto :	ditto, upper surface, natural size.
3.	Ditto :	stem attacked, natural size.
4.	Ditto :	peridial cells, × 350.
5.	Ditto :	æcidiospore, × 350.
6.	Fragaria :	æcidiospore, × 350.
7.	Ditto :	uredospore, × 350.
8.	Ditto :	germinating uredospore, × 350.
9.	Ditto :	teleutospore, × 350,
10.	Valeriana :	æcidiospore, × 400.
11.	Anemone :	outline of leaf showing attack : natural size.
12.	Ditto :	æcidiospore. × 480.
13.	Thalictrum :	peridial cells, × 350.
14.	Ditto :	æcidiospore, × 350.
15.	Ditto :	basal cells of a row of æcidiospores showing intermediate cells, × 480.

Plate XIV.

1.	Thalictrum	portion of shoot showing petioles attacked, natural size.
2.	Jasminum	peridial cells, × 350.
3.	Ditto	æcidiospores, × 350.
4.	Euphorbia	*a.* leaf, natural size. *b.* same somewhat enlarged.
5.	Ditto	*a.* æcidiospore, × 350. *b.* peridial cell, × 350.
6.	Ditto	transverse section of leaf showing peculiar disposition of mycelium and superficial nature of spermogonium.
7.	Ditto	*a.* layer of mycelial filaments on lower side of leaf ; *b.* same on upper side, × 480.
8.	Berberis	æcidiospore, × 350.
9.	Ditto	peridial cells, × 350.
10.	Ditto	two isolated peridial cells, × 350.

Plate XV.

1.	Andrachne	under surface of affected leaf, natural size.
2.	Ditto	upper surface.
3.	Berberis	upper surface of attached leaf, natural size.
4.	Berberis	peridial cells, × 350.
5.	Pyrus	peridial cells, × 350.
6.	Ditto	æcidiospores, × 350.
7.	Euphorbia	æcidiospore germinating, × 350.
8.	Ditto	germinating æcidiospore, showing formation of secondary spore (sporidium) and its germination while *in situ*, × 350.
9.	Ditto	secondary spore (sporidium), × 350.
10.	Andrachne	peridial cells, × 350.
11.	Ditto	æcidiospores, × 350.
12.	Ditto	showing end of germinal tube (promycelium ?) of æcidiospore with commencing formation of secondary spore or sporidium, × 350.
13.	Ditto	completely developed secondary spore, × 350.
14.	Ditto	showing germination of secondary spore (sporidium) 350.
15.	Myriactis	*a.* row of æcidiospores ; *b.* isolated spore ; *c.* and *d.* peridial cells, × 350.

16. Flower head of *Thalictrum minus* completely involved and distorted by the Æcidium, natural size, approximately.

17. Leaf of same. Leaf deeply hollowed, much enlarged and thickened, and covered profusely with æcidia outside with a few tubes also inside, natural size, approximately.

XXII.—*Natural History Notes from H. M.'s Indian Marine Survey Steamer* 'Investigator,' *Commander* ALFRED CARPENTER, R. N., *Commanding, No. 8. Description of a new species of the Brachyurous Genus* Lyreidus *from the Depths of the Andaman Sea.*—*By* J. WOOD-MASON, ESQ., *Superintendent of the Indian Museum, and Professor of Comparative Anatomy and Zoology in the Medical College of Bengal, Calcutta.*

LYREIDUS GRACILIS, n. sp.

♂. Very closely allied to *L. channeri.*[*] Body and legs slenderer. Rostrum acutely triangular with straight sides. Extraorbital and antero-lateral spines absolutely as well as relatively longer. The head being narrower and more produced, its sides (between the extraorbital and anterior antero-lateral spines) are less deeply hollowed out, and its supraorbital borders, more deeply and narrowly emarginate. Eye-peduncles and corneæ equal and similar, apparently of the same form and proportions as in the left eye of *L. channeri,* the former reaching to about the junction of the second with the apical third of the length of the rostrum, the latter opaque yellow with the subjacent pigment showing through the cuticle as a dark ring round their bases. Propodite of the chelipeds armed below with three triangular spines. The meropodite bears two sharp erect spinules about the middle of the length of its upper border. In all other respects much as in *L. channeri.*

The unique example obtained measures :—

	Millims.
Length of carapace, from tip of rostrum to posterior margin, ...	23·3
" " " " to middle of a straight line joining bases of posterior anterolateral spines, ...	8·5
" " from same straight line to posterior margin,	15·0
Breadth of carapace, across the parallel-sided part, ...	12·7
Breadth of head, between tips of extraorbital spines,... ...	4·7
Distance between tips of posterior antero-lateral spines, ...	17·9
Length of posterior antero-lateral spines, ...	5·4
" " anterior " " "	3·7
" " rostrum, from a straight line tangent to the bottoms of the supraorbital emarginations, ...	3·0
" " extraorbital spines from the same tangent, ...	4·0

Locality.—Off Port Blair; 271 fathoms; green ooze; January 2nd, 1888.

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[*] Supra, p. 206 *et seqq*, pl. i.

J. WOOD-MASON, Journ. Asiat. Soc. Bengal, 1887, Vol LV Pt. II

Pl. I

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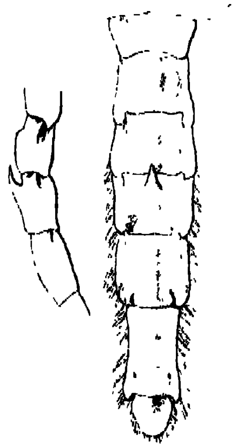

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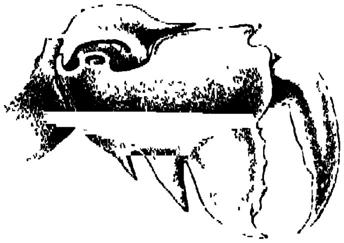

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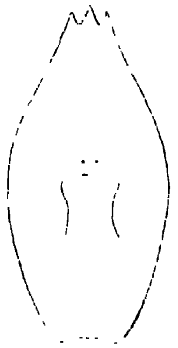

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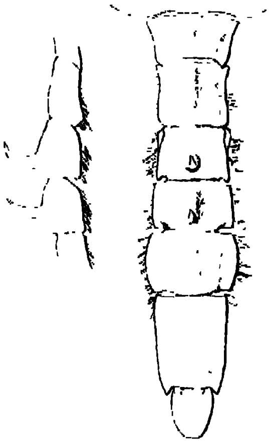

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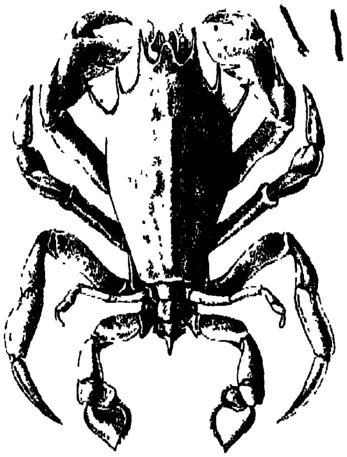

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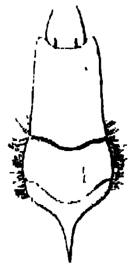

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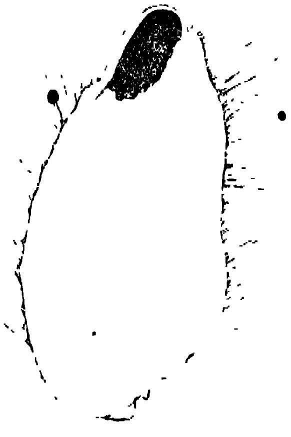

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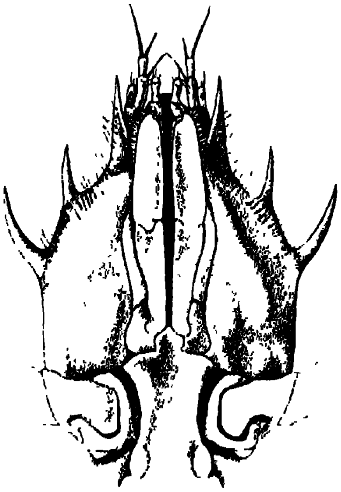

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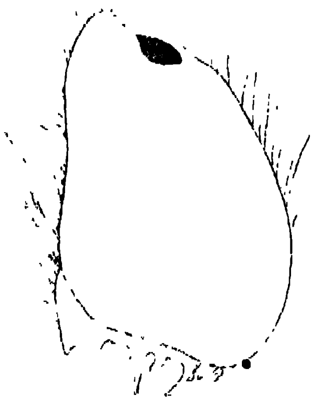

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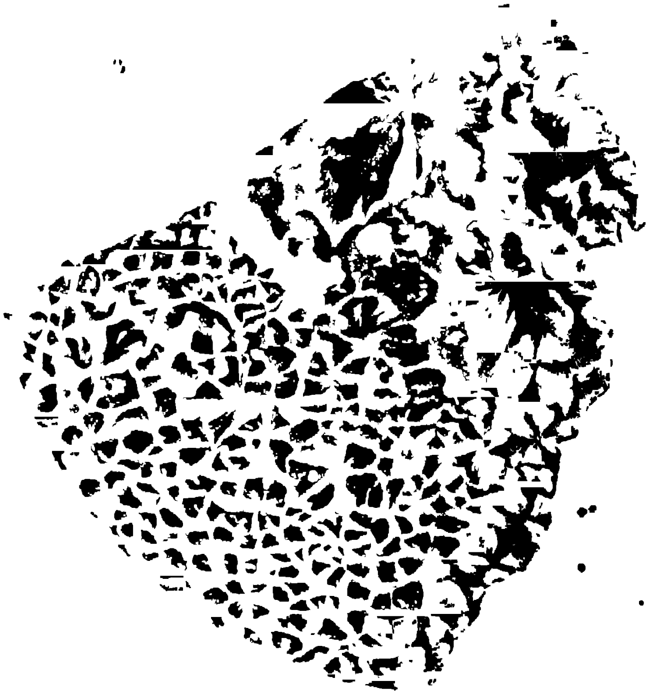

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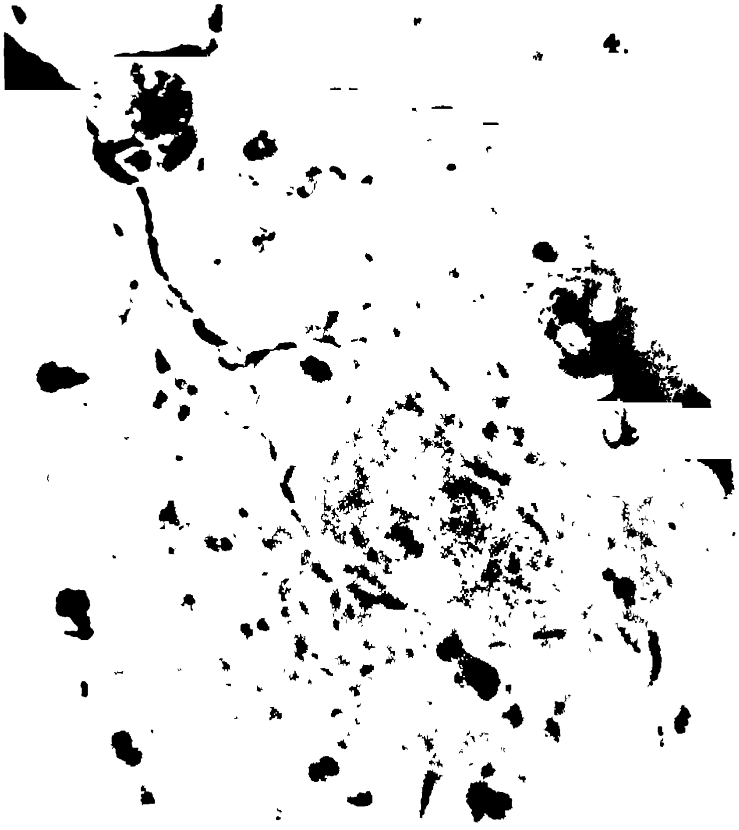
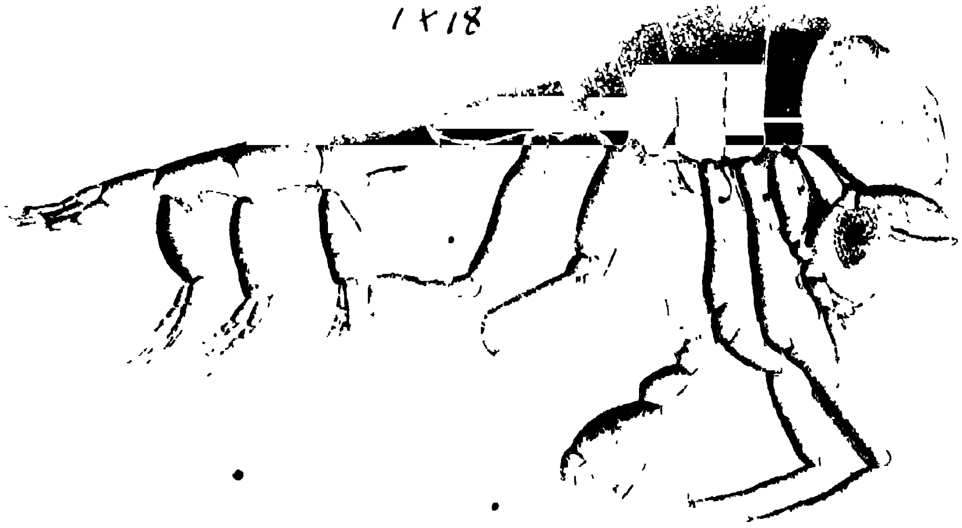
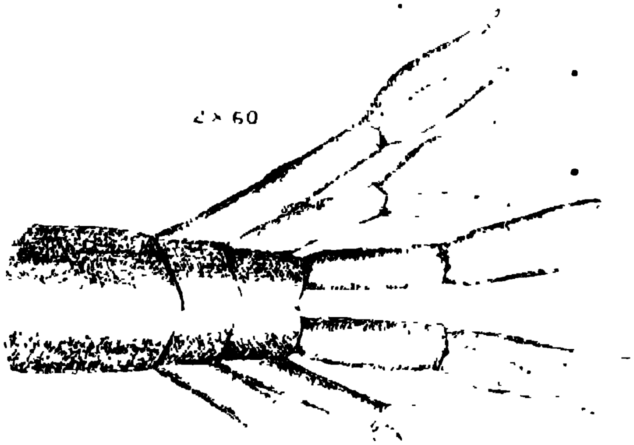
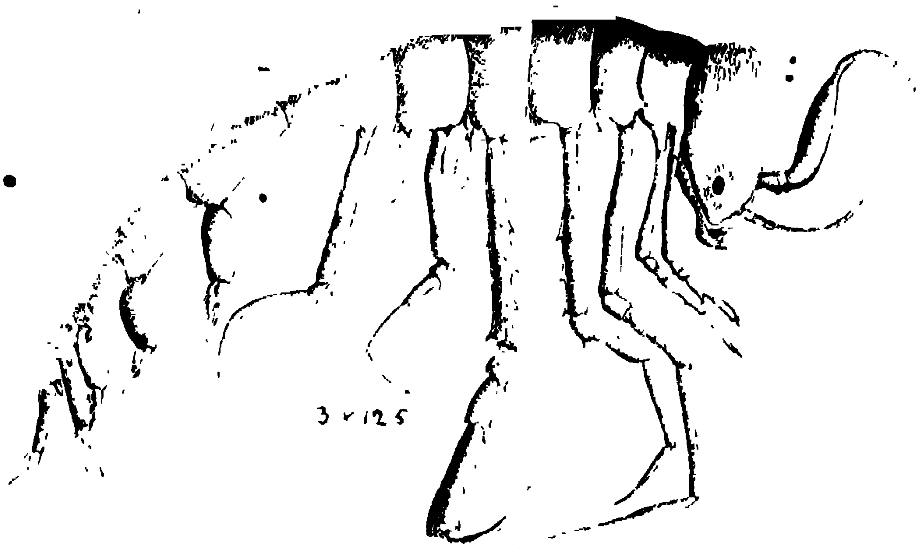


G.M.GILES, Journ. Asiat. Soc. Bengal. 1887 Vol. LVI. Pt.II. Pl. III.







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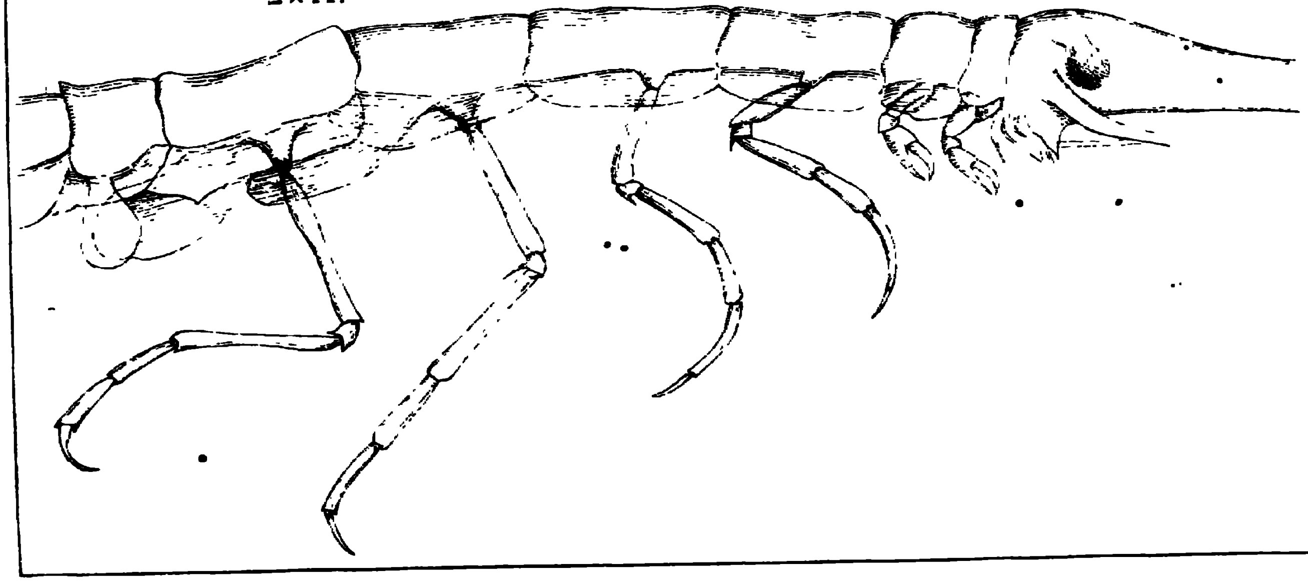
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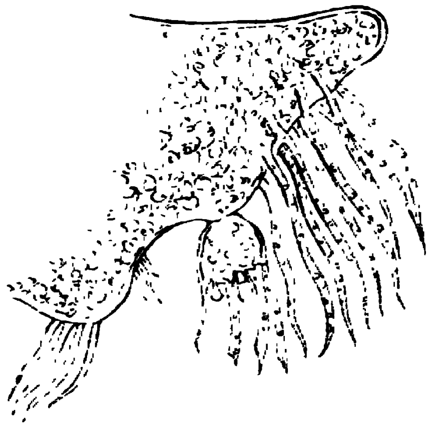
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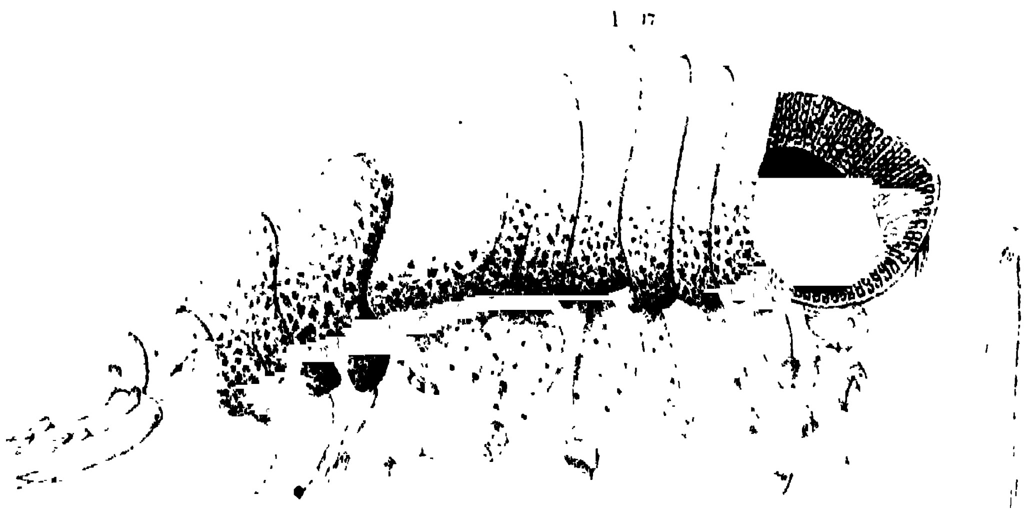

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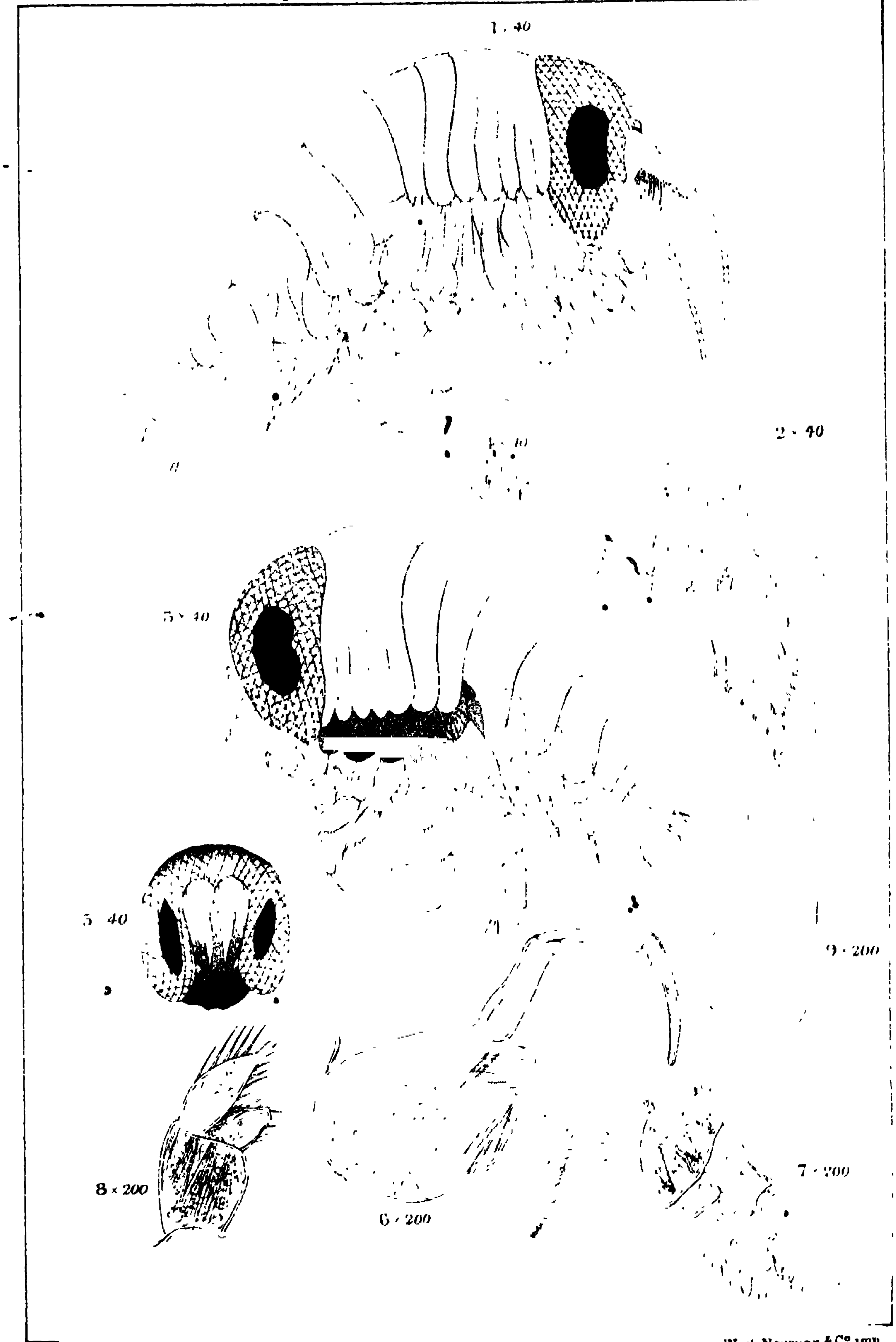

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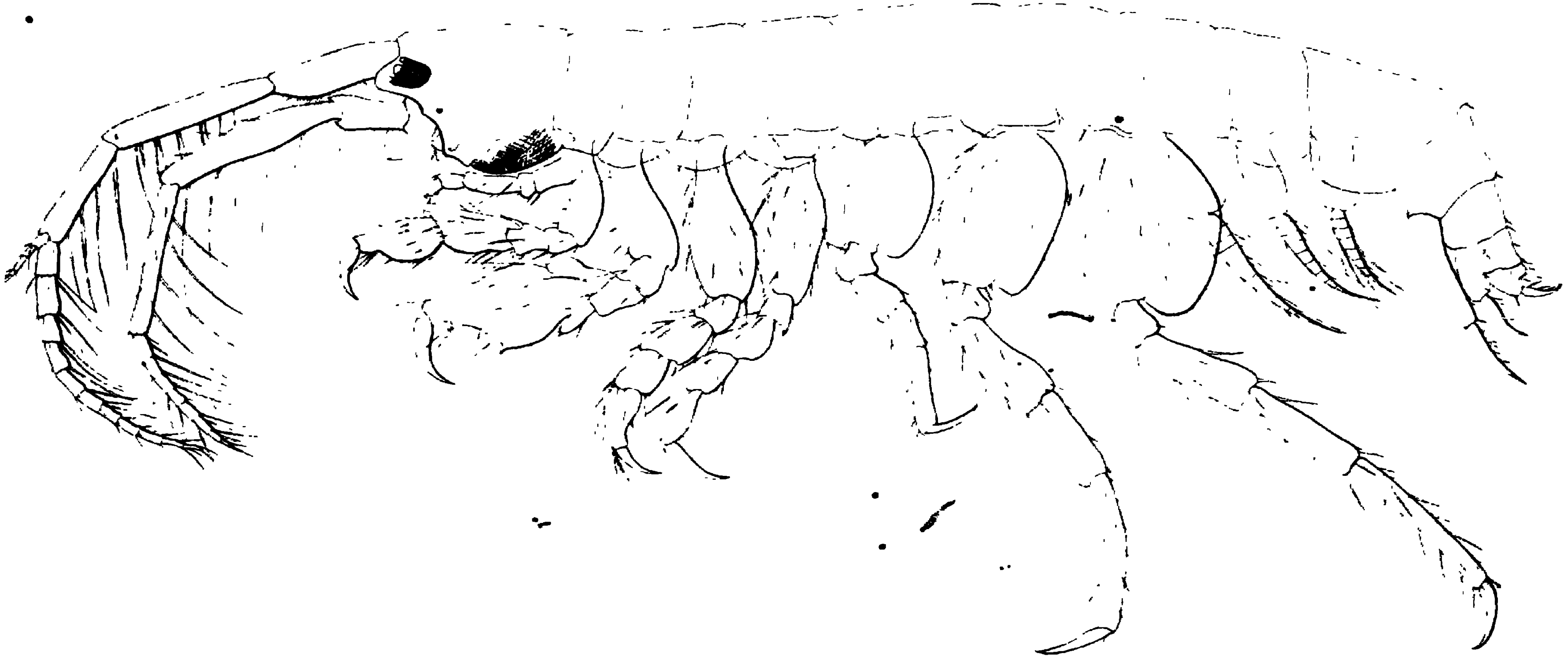
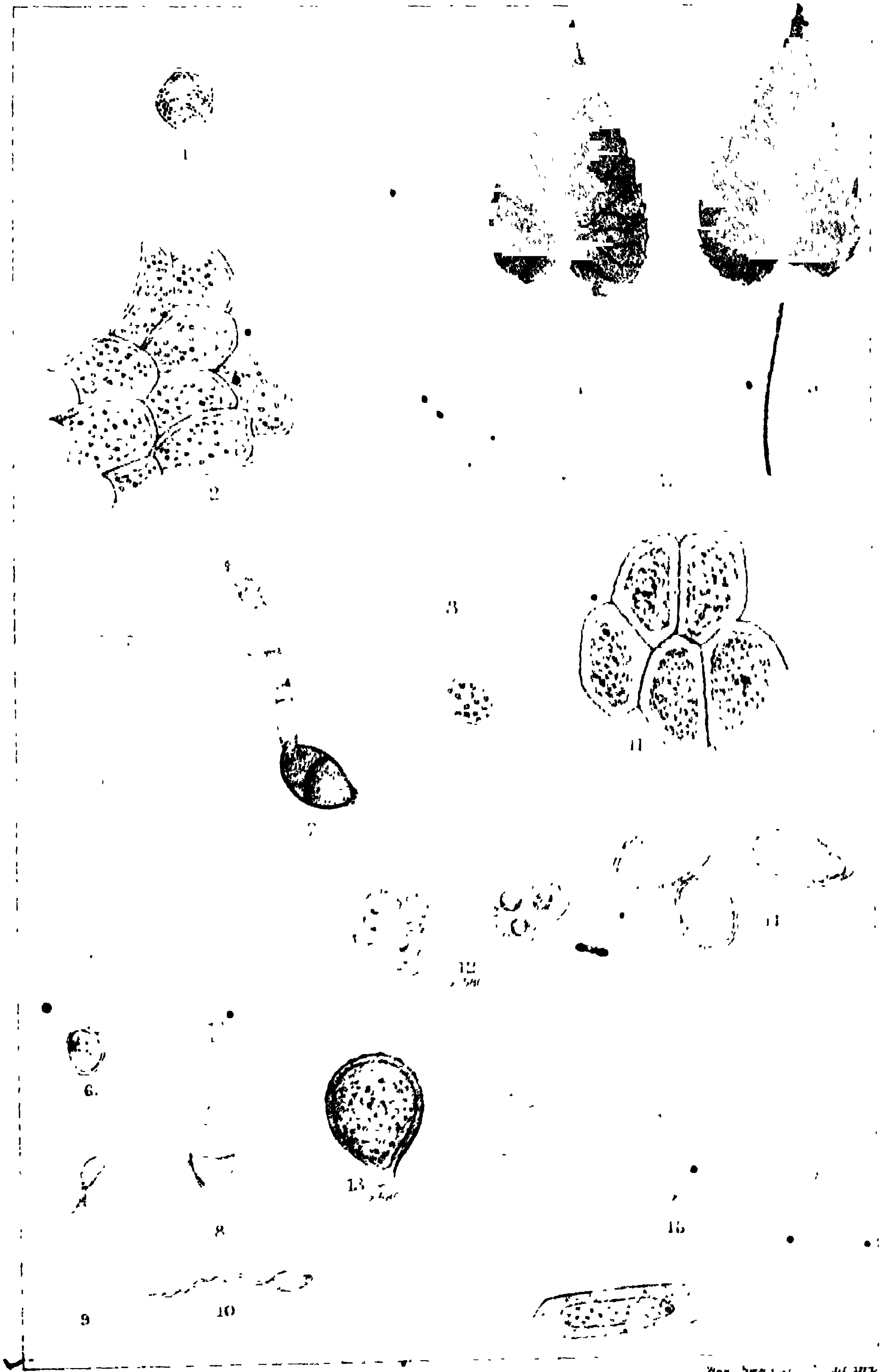
ES, Journ. Asiat. Soc Bengal, 1887, Vol LV Pt II

Pl VIII



A. BARCLAY. Journ. Asiat. Soc. Bengal. 1887. Vol. LVI. Pt. II.



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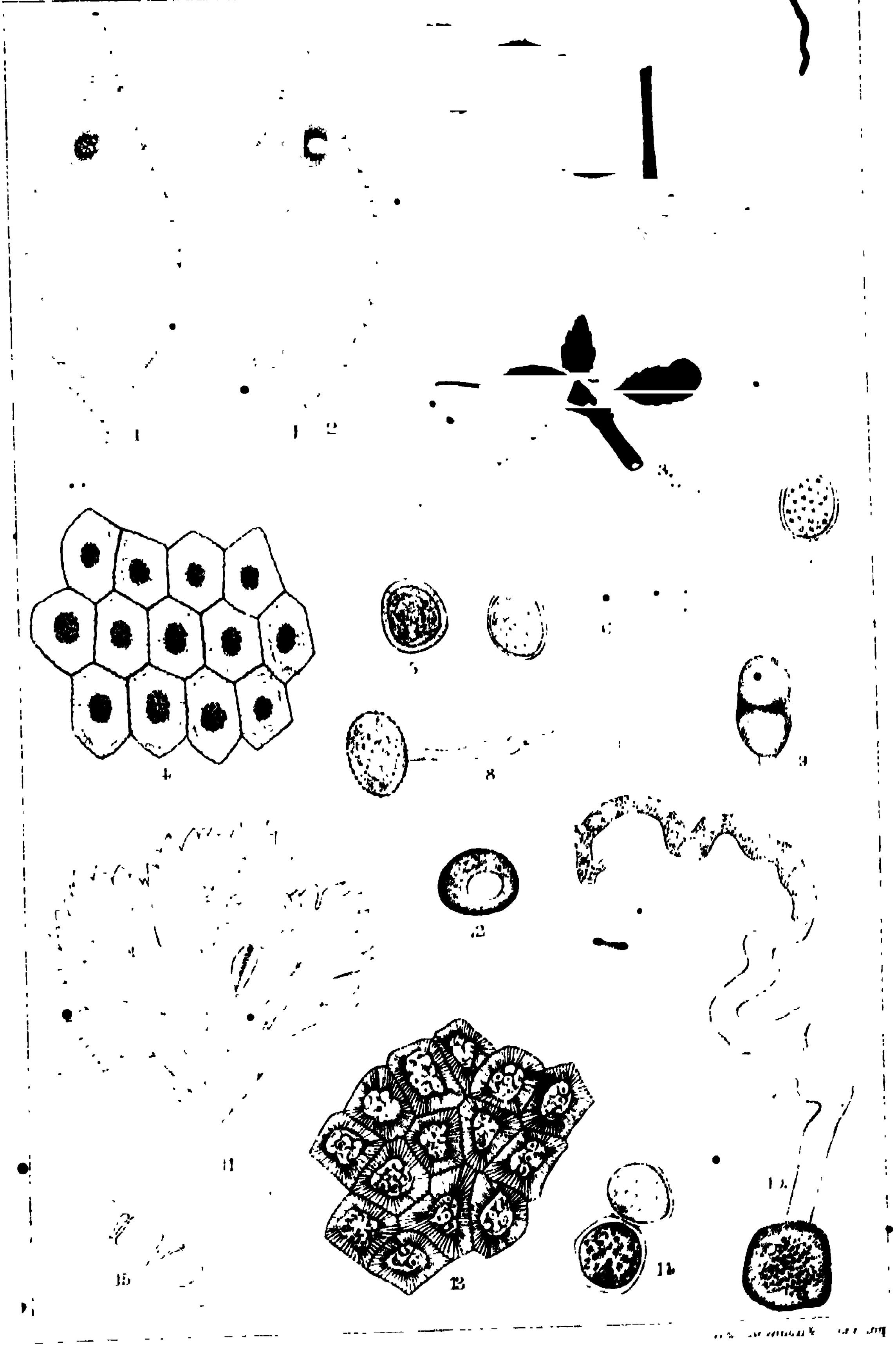

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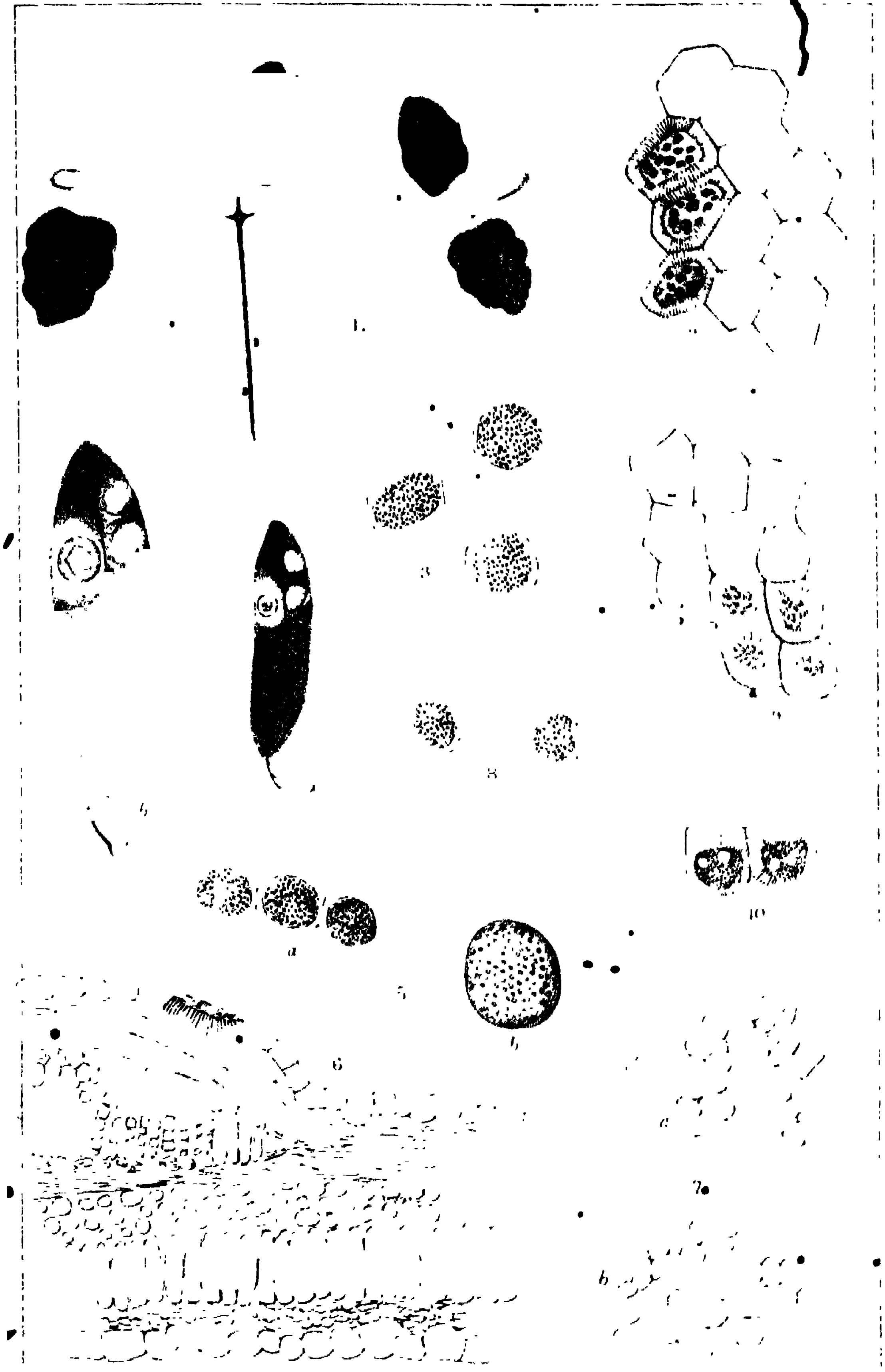

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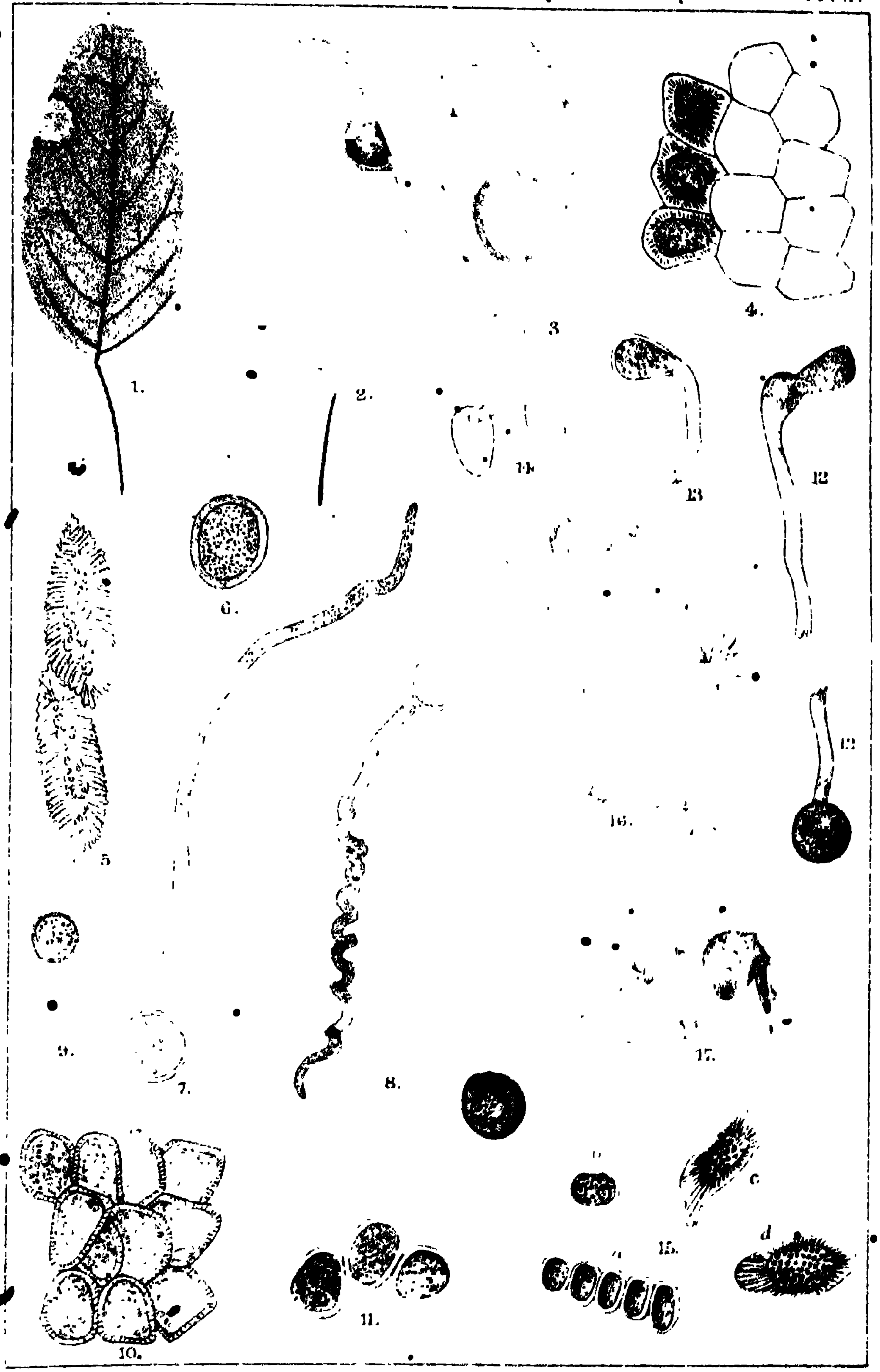

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JOURNAL

OF THE

ASIATIC SOCIETY OF BENGAL.

VOL. LVI.

PART II. (NATURAL HISTORY, &C.)

(NOS. I. TO V.—1887.)

EDITED BY

THE NATURAL HISTORY SECRETARY.

> "It will flourish, if naturalists, chemists, antiquaries, philologers, and men of science in different parts of *Asia* will commit their observations to writing, and send them to the Asiatic Society at Calcutta. It will languish, if such communications shall be long intermitted; and it will die away, if they shall entirely cease." SIR WM. JONES.

CALCUTTA:
PRINTED BY G. H. ROUSE, AT THE BAPTIST MISSION PRESS,
AND PUBLISHED BY THE
ASIATIC SOCIETY, 57, PARK STREET.
1887

INDEX.‡

Names of New Genera and Species have an asterisk (*) prefixed.

Abies smithiana, 373
Accipiter melaschistus, 78
  ,, nisus, 78
Acrocephalus stentoreus, 81
Actinacantha propinqua, 104
Æcidium compositarum, 373
  ,, euphorbiæ, 366
  ,, fragariæ, 361
* ,, jasmini, 363
  ,, leucospermum, 361, 362
  ,, punctatum, 361
* ,, saniculæ, 352
  ,, strobilanthis, 351, 369
  ,, thalictri flavi, 362, 363
  ,, urticæ, 351
  ,, ,, var. himalayense, 368
Ægialites curonica, 87
Alauda cristata, 84
  ,, guttata, 84
***Amphipronoë longicornuta, 212, 220, 229**
Anas angustirostris, 88
  ,, crecca, 88
  ,, penelope, 88
  ,, strepera, 88
Andrachne cordifolia, 351, 366, 367, 371
Anemone nemorosa, 361, 362
  ,, ranunculoides, 361, 362
  ,, rivularis, 361, 362
Anthus blakistoni, 84
  ,, rosaceus, 84
Aranea, 107
Argiope, 287
Arvicola guentheri, 72
Ascyltus, 283
Asio otus, 79
***Atmetochilus, 109**
* ,, fossor, 109
Attus, 101
  ,, forceps, 283
Barbastellus communis, 258
Berberis, aristata, 367
  ,, lycium, 368
  ,, vulgaris, 368
Brachypodium sylvaticum, 359
Budytes citreola, 83
  ,, melanocephala, 83
Buteo ferox, 78
Buthus bengalensis, 112
Cærostris paradoxa, 107
Calandrella brachydactyla, 84
Canis lupus, 69
Caprimulgus europæus, 79
  ,, unwini, 79
Carduelis caniceps, 84
Carex setigera, 369
Carine bactriana, 79
Casarca rutila, 89
Cedrus deodara, 373
Cervus cashmirianus, 76, 77
  ,, maral, 77
Cettia cetti, 81
Chettusia villotæi, 87
Chiracanthium, 287
Cinclus asiaticus, 83
Circus æruginosus, 78
  ,, cineraceus, 78
  ,, cyaneus, 77
  ,, macrurus, 78
Citillus leptodactylus, 71
Clangula glaucion, 89
Cocalus, 283
  ,, concolor, 283
  ,, cyaneus, 283
  ,, salax, 283
Columba eversmanni, 86
  ,, intermedia, 86
Coracias garrula, 79
Corvus frugilegus, 85
  ,, monedula, 85
  ,, splendens, 257
Coturnix communis, 87
Cotyle riparia, 83
  ,, rupestris, 83
Crex pratensis, 88
Cupressus torulosa, 371
Cyanecula suecica, 82
***Cyclosa albisternis, 285**
* ,, ,, var., 286

---

‡ **A complete Index to the articles on *Rhynchota* published in this volume will be issued with the last of the series in a subsequent volume.**

*Cyclosa anseripes, 286
Cyllobelus, 283
* ,, miniaceomicans, 283
Cynonycteris amplexicaudata, 237, 238, 240, 257
Cynopterus brachyotus, 239
,, marginatus, 237, 238, 239, 240, 257, 258
Cypselus apus, 79
,, melba, 79
*Cyriopagopus, 110
* ,, paganus, 111
Cystauchenium, 109
Cytæa, 283
* ,, albolimbata, 282
,, alburna, 282
,, sinuata, 282
Dendrophthoe coccinea, 91
,, farinosa, 94
,, ferruginea, 92
,, ignea, 93
,, macrocalyx, 91
,, pentandra, 94
,, pentapetala, 90
,, pulcher, 90
Dolomedes ocyale, 101
Ellobius, 75
,, fuscocapillus, 74, 75
* ,, intermedius, 73, 74, 75
,, talpinus, 74, 75
,, ,, var. rufescens, 75
Elytranthe albida, 98
,, avenis, 97
,, farinosa, 94
,, formosa, 95
,, sphæroidea, 97
Emberiza fucata, 85
,, pyrrhuloides, 85
,, schæniclus, 85
Endophyllum euphorbiæ-silvaticæ, 366
Epeira, 107, 287
,, anama, 107
,, caput-lupi, 107
,, dehaani, 106, 107
* ,, masoni, 105
,, rhodosternon, 107
* ,, submucronata, 106
Erinaceus albulus, 68, 69
,, auritus, 69
Erismatura leucocephala, 89
Erythrospiza obsoleta, 84
Erythrosterna parva, 80
Euphorbia amygdaloides, 366
,, cognata, 351, 364, 372
Euryattus, 283
*Eurystheus hirsutus, 212, 227, 229
Euspiza luteola, 85
Felis caudáta, 69
Ficus, 61, 64, 65
,, alba, 67
* ,, arfakensis, 63
* ,, brachiata, 65
Ficus chartacea, 64
* ,, comitis, 68
* ,, conora, 62
* ,, conspicabilis, 61
* ,, d'albertisii, 64
* ,, dimorpha, 66
* ,, dumosa, 67
* ,, forbesii, 66
* ,, grandis, 64
* ,, mespiloides, 62
,, miquelii, 65
,, ribes, 66
,, roxburghii, 64
Fragaria vesca, 351, 359
Fulica atra, 88
Fuligula cristata, 88
,, nyroca, 89
Gagrella, 115
* ,, binotata, 115
* ,, cervina, 115
* ,, quadravittata, 115, 116
,, signata, 117
Gallinago scolopacinus, 87
,, solitaria, 87
Gasteracantha, 104
,, annamita, 105, 284
,, frontata, 105
Gazella subgutturosa, 76
Geranium nepalense, 374
Gerbillus erythrurus, 72
,, hurrianæ, 71, 72
Gymnosporangium clavariæforme, 870, 371
,, juniperinum, 371
Harpyiocephalus, 252
,, harpia, 258, 259
,, leucogaster, 251, 252
Hasarius, 283
,, adansoni, 283
Hersilia, 287
*Heteropoda ferina, 102
* ,, languida, 102
,, mediocris, 102
,, venatoria, 102
Himantopus candidus, 87
Hippasa greenalliæ, 101
Hipposideros fulvus, 248
Hirundo rustica, 83
Homalattus, 287
Hormurus australasiæ, 113
Hyperia, 224, 226, 227
Hyperina, 212
Hypolais pallida, 81
,, rama, 81
Ischnurus australasiæ, 113
,, pistaceus, 113
Isometrus varius, 112
Jasminum grandiflorum, 364, 374
,, humile, 363, 374
,, officinale, 364, 374
,, revolutum, 351
Lagomys rufescens, 75

Lanius isabellinus, 80
,, phœnicuroides, 80
Larus ridibundus, 88
Leptoctenus denticulatus, 108
,, pullus, 108
* ,, tumidulus, 108
Leptopelma, 287
Lepus lehmanni, 76
Lestrigonus, 224, 227
* ,, bengalensis, 212, 224, 225, 227, 229
,, forus, 225
,, fuscus, 225
Liocheles, 113
,, australasiæ, 113
,, complanatus, 113
,, neocaledonicus, 113
Loranthus, 89, 90, 99
,, albidus, 98
,, ampullaceus, 97
,, avenis, 97
,, axanthus, 90
* ,, beccarii, 98
,, bengalensis, 92
,, carinulatus, 97
,, coccineus, 90, 91, 95
,, concavifolius, 92
,, contractus, 94
* ,, crassipetalus, 91
,, curvatus, 95
,, dianthus, 96
* ,, duthicanus, 94
,, eleutheropetalus, 91
,, erythrostachys, 90
,, evenius, 97
,, farinosus, 94
,, ferrugineus, 92
,, finlaysonianus, 91
* ,, forbesii, 100
,, formosus, 95, 96
,, globosus, 97
,, graciliflora, 92
* ,, grandifrons, 93
,, heteranthus, 91
,, kingii, 99
* ,, kunstleri, 95
,, lævigata, 92
* ,, lampongus, 100
,, lecucosiphon, 98
,, lobbii, 90
,, longiflorus, 93
* ,, lowii, 98
,, loxantherus, 95
,, lyndenianus, 90
,, malaccensis, 93
,, meluitangensis, 96
,, obtectus, 92
,, oleifolius, 97
,, oortianus, 92
,, pallens, 97
,, parishii, 90
,, pentandrus, 93
Loranthus pentapetalus, 90
* ,, platyphyllus, 97
,, polycarpus, 90
* ,, productus, 91
,, pulcher, 90
,, racemiferus, 91
,, reinwardtianus, 95
,, retusus, 98
,, rigidus, 94
,, schultesii, 93
* ,, scortechinii, 94
,, scurrula, 93
,, ,, var. obtecta, 92
,, speciosus, 90, 95
,, sphaerocarpus, 97
,, sub-globusus, 97
,, sub-umbellatus, 97
;, viridiflorus, 97
Lycosa, 101
,, virulenta, 101
Lyreidus bairdii, 208
* ,, channeri, 206, 208, 376
,, elongatus, 208
* ,, gracilis, 376
* ,, stenops, 209
,, tridentatus, 207, 208, 209
Machetes pugnax, 87
Macrosolen, 97
,, formosus, 95
,, oleioides, 97
,, pallens, 97
,, sphaerocarpus, 97
Mævia, 283
Maracandus, 114
,, macei, 114
,, mouhoti, 114
* ,, reticulatus, 113
Megaderma lyra, 242, 258
Melanocorypha bimaculata, 84
Menemerus culicivorus, 101
Mergus albellus, 89
Merops apiaster, 79
Merula atrigularis, 81
,, maxima, 81
,, vulgaris, 81
Meta, 286, 287
,, fastigiata, 107
,, fastuosa, 107
Milvus migrans, 78
Miniopterus schreibersi, 251, 254, 256, 257
Moggridgea, 287
*Monosporidium, 351, 364, 367, 371
* ,, andrachnis, 371
* ,, euphorbiæ 364, 372, 373
Monticola cyanus, 82
Motacilla alba, 83
,, melanope, 83
Murina leucogaster, 251
,, suillus, 258
Mus bactrianus, 72
,, pachycercus, 72

Myriactis nepalensis, 373
Nephila, 287
,, fuscipes, 107
,, maculata, 107
,, rivulata, 107
Nephilengys hofmanni, 107
,, malabarensis, 107
Noctulinia lasyura, 258
Nycticejus nivicolus, 259
Ocyale atalanta, 101
Otis tetrax, 87
Oxyopes, 287
Palamnæus bengalensis, 112
Palystes kochi, 103
Paraphronima, 214
Passer hispaniolensis, 85
,, indicus, 84
,, montanus, 84
Pastor roseus, 86
Phalacrocorax carbo, 88
Phasianus colchicus, 86
,, principalis, 86
,, shawi, 86
Phœnicanthemum bennetianum, 91
,, coccineum, 91
,, pentapetalum, 90
Pholcus distinctus 108
,, elongatus, 107, 108
,, margarita, 108
,, phalangioides, 107
,, tipuloides, 108
Phrictus flavopilosus, 110
Phronima, 212, 213, 214
* ,, bucephala, 212, 213, 214, 215, 229
,, sedentaria, 21
Phronimella, 214
* ,, hippocephala, 212, 213, 214, 217, 229.
Phronimopsis, 214
Phryctus, 111
Phyllorhina amboinensis, 248, 249
,, armigera, 245, 247, 248
,, bicolor, 248
,, fulva, 248
,, micropus, 249
Pica rustica, 85
Pimpinella diversifolia, 352, 356
Pinus excelsa, 373
,, longifolia, 373
Plecotus auritus, 242, 258
,, darjilingensis, 258
,, homochrous, 258
Plexippus, 283
,, aper, 283
,, argentosus, 283
,, catellus, 283
,, culicivorus, 101
,, erythrocephalus, 283
,, expectans, 283
,, frontaliger, 283
,, laticeps, 283
Plexippus nimbatus, 283
,, ochropus, 283
,, pupulus, 283
,, ruber, 283
,, severus, 283
Pollinia nuda, 369
Porzana bailloni, 88
,, maruetta, 88
Pratincola caprata, 80
,, maura, 80
Priata agelenoides, 101
Psecas, 283
Pterocles alchata, 86
Pteropus amplexicaudatus, 237
,, leucocephalus, 236
,, marginatus, 239
,, medius, 236, 238, 257
,, pyrivorus, 237, 238, 258
Ptocasius, 283
Puccinia anemones, 361
,, coronata, 358, 359
,, flosculosorum, 373
* ,, fragariæ, 359, 361
,, fusca, 362
,, graminis, 367, 368
,, pimpinellæ, 356, 358
,, violæ, 354, 356
Pyrus variolosa, 359, 370
Rallus aquaticus, 87
Ranunculus diffusus, 374
Rhabdosoma, 221
,, armatum, 219, 220
* ,, investigatoris, 212, 219, 220, 229
,, whitei, 219, 220
Rhamnus dahuricus, 358
Rhinolophus affinis, 242, 257
,, armiger, 245
Rhinolophus ferrum-equinum, 245
,, luctus, 240, 241
,, macrotis, 241, 242, 258
,, minor, 240, 243, 244, 245
,, perniger, 240
,, subbadius, 243, 244
,, tragatus, 245
Ruticilla erythronota, 82
,, rufiventris, 82
Sageretia oppositifolia, 359
Salticus collingwoodi, 283
,, forceps, 283
,, sinuatus, 283
,, (Attus) forceps, 283
Sanicula, 374
,, europæa, 352
Sarpedon, 286
*Satzicus, 286
* ,, andamanicus, 287
Saxicola deserti, 82
,, finschii, 82
,, isabellina, 82
,, morio, 82
,, opistholeuca, 82

Scæa, 283
Scelospizias badius, 78
Scolopax rusticula, 87
*Scorpiops anthracinus, 112
,, hardwicki, 113
,, montana, 113
,, solidus, 113
Scotophilus fuliginosus, 250, 251, 257
Selenocosmia, 110
Servæa, 283
Sitta syriaca, 83
Spermophilus, 71
* ,, bactrianus, 70
,, brevicauda, 71
,, citellus, 71
,, concolor, 71
,, dauricus, 71
,, erythrogenys, 71
,, eversmanni, 71
,, fulvus, 71
,, guttatus, 71
,, leptodactylus, 71
,, mongolicus, 71
,, mugosaricus, 71
,, musicus, 71
,, rufescens, 71
,, xanthoprymnus, 71
*Sphedanus, 284
,, marginatus, 284
,, undatus, 284
Stanneoclavis brevispina, 285
,, canningensis, 285
Sterna anglica, 88
,, minuta, 88
Strobilanthes dalhousianus, 351, 369
Sturnus poltaratskyi, 86
Sturnus vulgaris, 85
Sylvia affinis, 80
,, familiaris, 81
,, minuscula, 80
,, mystacea, 81
,, rubescens, 81
Synotus darjilingensis, 258
Tadorna vulpanser, 89
Tetragnatha gracilis, 286
Tetraogallus himalayensis, 86
Thalictrum javanicum, 362
,, minus, 363, 375
*Thelictopis canescens, 103
,, severa, 104
Thelyphonus assamensis, 111
,, formosus, 111
Tinnunculus alaudarius, 79
,, conchris, 79
Tityus varius, 112
Totanus ochropus, 87
Tringoides hypoleucus, 87
Troglodytes nipalensis, 83
,, parvulus, 83
Turtur auritus, 86
Upupa epops, 80
Uromyces junci, 373
,, pisi, 366
,, scutellatus, 366
,, valerianæ, 351, 352, 354
Urtica parviflora, 351, 368
Valeriana wallichii, 351, 352
Vanellus cristatus, 87
Vespertilio abramus, 250
,, adversus, 255
,, caliginosus, 256
,, darjilingensis, 258
,, ferrum-equinum, 245
,, formosa, 254, 256
,, formosus, 254
,, fuliginosa, 254, 256, 257
,, fuliginosus, 251
,, labiata, 250, 256
,, muricola, 255, 256
,, mystacinus, 242, 254, 255, 256, 258
,, nipalensis, 253, 258
,, noctula, 250, 256
,, pallidiventer, 253
,, pallidiventris, 253
,, schreibersii, 256
,, siligorensis, 255, 258
,, subbadia, 243
Vesperugo abramus, 250, 251, 257
,, noctula, 250
Viola serpens, 354
Vulpes montana, 69, 70